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July 1953

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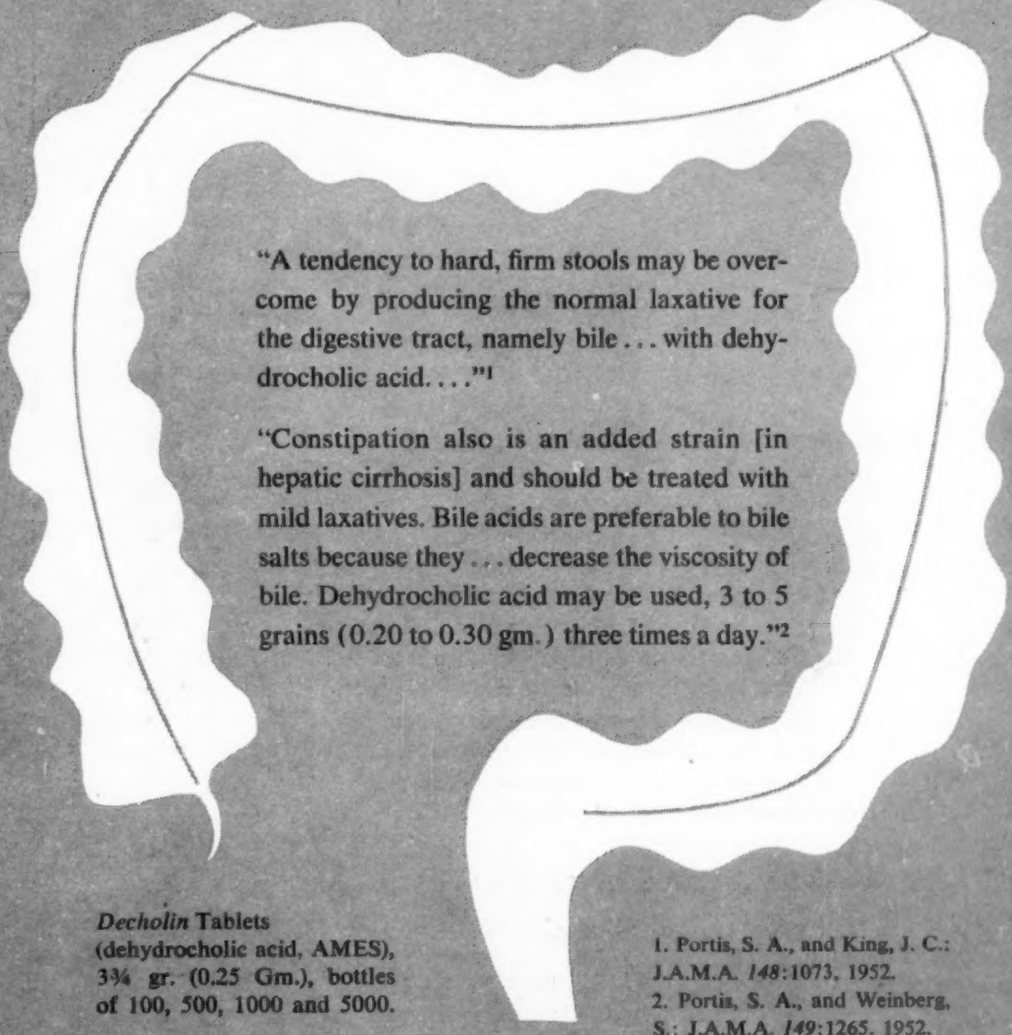

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1. Portis, S. A., and King, J. C.: J.A.M.A. *148*:1073, 1952.
2. Portis, S. A., and Weinberg, S.: J.A.M.A. *149*:1265, 1952.

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Editorial

SURGICAL TREATMENT OF CANCER OF THE CERVIX . . . . . *Alexander Brunschwig* 1

Original Articles

FREEZE-DRIED AORTIC GRAFTS. A PRELIMINARY REPORT OF EXPERIMENTAL EVALUATION . *Lieut. James W. Pate and Lieut. Philip N. Sawyer* 3

A detailed experimental evaluation of freeze-dried aortic grafts in dogs. The first seventy homografts completed form the basis of this preliminary report.

ANALYSIS OF ANESTHETIC SAFEGUARDS. REPORT OF A NATIONAL SURVEY . . . . . *Herman W. Schweizer and Paul M. Wood* 14

An analysis of the returns of a nationwide survey on anesthetic safeguards currently practiced in operating rooms. It reviews the physical and chemical factors which are responsible for the elaboration of electrostatic charges. This article should be carefully studied by surgeons and anesthetists.

CARDIAC ARRHYTHMIAS DURING ANESTHESIA. A COMPARISON OF CYCLOPROPANE AND PENTOTHAL-NITROUS OXIDE-ETHER ANESTHESIA . . . . . *Jack L. Eisaman, Harold D. Caylor, Charles E. Jackson and Helen Roe* 23

Statistical data are given on the incidence of arrhythmias induced during 334 major surgical cases. Under cyclopropane anesthesia 62 per cent had some type of arrhythmia, under pentothal-induced nitrous oxide-ether anesthesia 9 per cent. A case of cardiac arrest occurred in each group and these are included as case reports.

EMERGENCY INFRACOSTAL APPROACH FOR CARDIAC ARREST . . . . . *David J. Wexler, Fred Bromberg and Anthony Kohn* 29

A discussion of the infracostal approach for manual massage of the heart in cardiac arrest. Presentation of the adjuvant measures useful in resuscitation. Illustrative cases are reported.

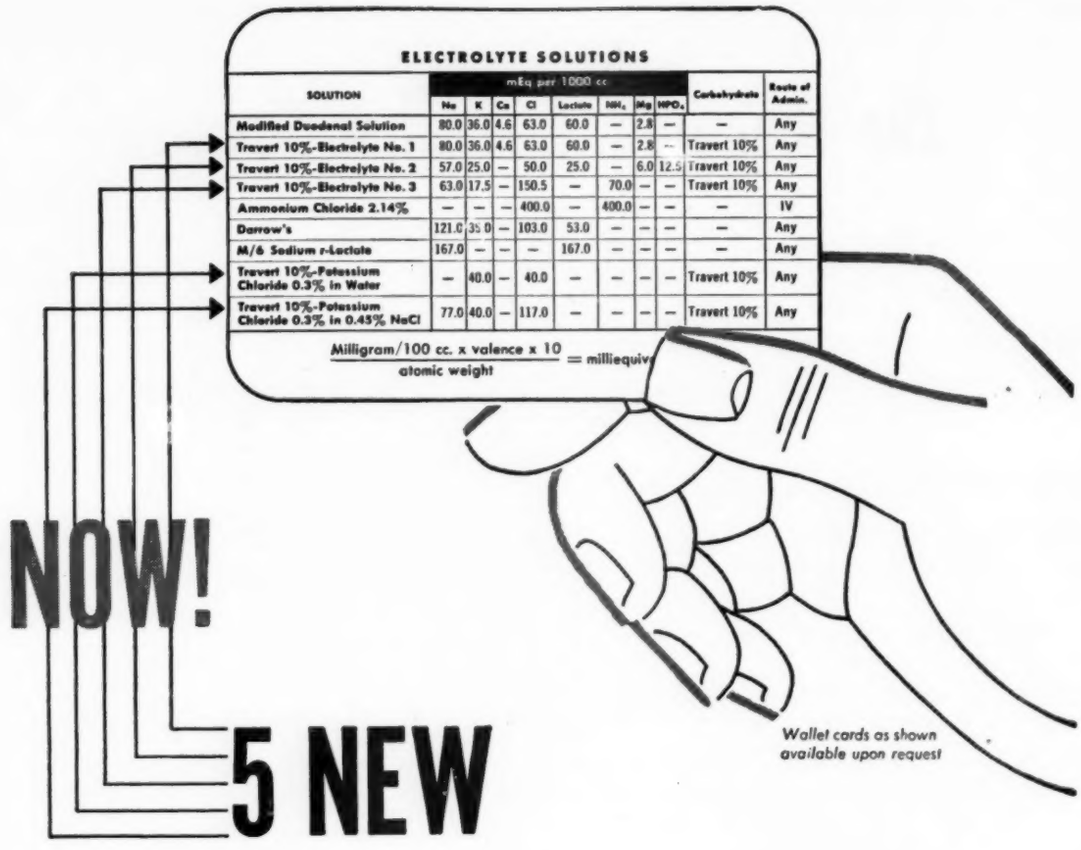
PHEOCHROMOCYTOMA . . . . . *Joseph L. DeCourcy* 37

A résumé of the diagnosis of pheochromocytoma in patients with hypertension. The hazard of the use of histamine and certain other agents is discussed, and one case is reported.

NEPHRECTOMY AND HYPERTENSION. THE EXPERIENCE IN ONE UROLOGIC CLINIC. . . . *Comdr. Stanley J. Okulicz and Victor F. Marshall* 45

A review of nephrectomy and hypertension at the New York Hospital. Illustrative case reports and the incidence of success.

Contents Continued on Page 5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VOL. LXXXVI — *Contents • July, 1953* — NUMBER ONE

A NEW METHOD OF ESTIMATING BLOOD LOSS DURING SURGERY . . . . *Frank Cole* 50

A new method is offered for determining blood loss during surgery. The quantity of blood that has been lost should be known at all times so that replacement will not fall behind the loss at any time during an operation.

RHINOPLASTY. PSYCHOGENIC ADJUNCT IN THE TREATMENT OF VASOMOTOR RHINITIS . . *Lester W. Eisenstodt* 53

The author postulates that the best surgical results (500 cases in his series) in the treatment of vasomotor rhinitis were attained by the simultaneous performance of rhinoplasty, submucous resection and bilateral amputation of the tips of the inferior turbinates during the height of the allergy season.

NEUROSURGICAL PROCEDURES FOR RELIEF OF INTRACTABLE PAIN . . . *Sidney W. Gross* 58

In discussing neurosurgical procedures for the relief of intractable pain the author evaluates peripheral nerve section, rhizotomy, cordotomy, sympathectomy and frontal lobotomy.

PERIPHERAL NERVE SURGERY. INCISIONS FOR EXPOSURES OF PERIPHERAL NERVES. . . . *Claude Pollard, Jr. and Everett G. Grantham* 61

After accurate planning and allowance for proximal and distal extension the authors describe a satisfactory method for exposing all of the major peripheral nerves.

REGIONAL ENTERITIS. RESULTS OF SURGICAL TREATMENT . . . . . *Louis T. Palumbo and Samuel C. Wittmer* 70

Sixteen cases of regional ileitis are presented, with no deaths. In the advanced group, an ileal exclusion with ileotransverse colostomy was done in 50 per cent of the patients, and in 50 per cent a one-stage resection of the small bowel and the right colon with an end-to-end ileotransverse colostomy was accomplished.

MESENTERICOPARIETAL HERNIA. REPORT OF THREE CASES. . . . . *Roscoe C. Giles, Edward Del Beccaro, William Klingensmith and Herbert Trace* 75

A presentation of two cases of left and one of right mesentericoparietal hernia, with successful operation. Considerations of etiology and a brief review of recent literature.

PAINFUL SCARS. . . . . *R. J. Behan* 81

The causes, symptoms and treatment of painful scars.

Modern Operative Technics

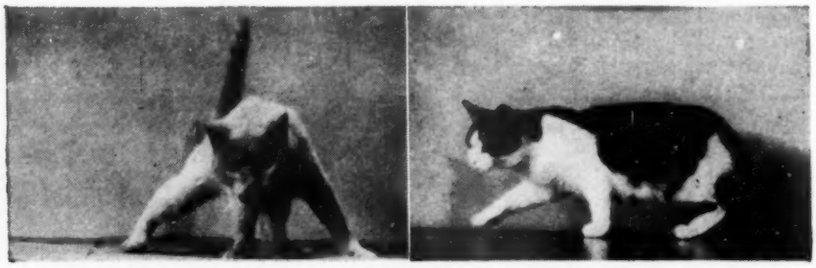
RECURRENT DISLOCATION OF THE SHOULDER. . . . . *Toufick Nicola* 85

The pathology of recurrent dislocation of the shoulder is not the same in all cases. Therefore the operative treatment should depend upon the pathologic condition present.

Contents Continued on Page 7

New principle
in
Streptomycin Therapy

The hazard of ototoxicity is greatly reduced by combining equal parts of streptomycin sulfate and dihydrostreptomycin sulfate. The patient thus gets only *half* as much of each drug. The risk of vestibular damage (from streptomycin) and of hearing loss (from dihydrostreptomycin) is greatly reduced. Therapeutic effect is undiminished. This principle has been demonstrated in both animals and man. In patients treated for 120 days with 1 Gm. per day of the combined drugs, the incidence of neurotoxicity was practically zero.



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Streamlined Article

WET SUSPENSION STAINING METHOD FOR RAPID EXAMINATION OF EXFOLIATED CELLS AND PARASITES FROM VAGINA AND INTESTINE . . . . . *Leonard R. Thompson* 92

The author describes a simple and rapid wet suspension staining technic for exfoliated cells and for material obtained by scraping or curetting in the detection of malignancy, estrogen level and infections due to trichomonas and monilia.

Case Reports

FOLLICULAR LYMPHOBLASTOMA OF THE ILEUM . . . . . *G. F. Wollgast, F. Robert Mizer and John W. Haskin* 98

Follicular lymphoblastoma is a systemic disease; it rarely starts in the small bowel. Two cases involving the jejunum have been reported and an additional case involving the ileum is added.

CONGENITAL MEGACOLON, ITS ETIOLOGY AND TREATMENT . . . . . *J. M. McCaughan, Joseph Ninecurt and Robert H. Ruby* 102

The result obtained in a case of congenital megacolon by resection of the non-dilated segment of the rectum and rectosigmoid with primary anastomosis.

RUPTURED MULTILOCULAR PSEUDOMUCINOUS CYSTADENOMA OF THE OVARY WITH PLEURAL EFFUSION . . . . . *Edison S. Shaw* 107

Presentation of a case of Meig's syndrome caused by multilocular pseudomucinous cystadenoma of the ovary.

VOLVULUS OF THE STOMACH . . . . . *John P. West and Vaun T. Floyd* 112

Symptoms suggestive of volvulus of the stomach. Diagnosis, treatment and a case report.

VOLVULUS OF THE CECUM . . . . . *Gerard Desforges and Hugh Wilson* 116

A case of volvulus of the cecum with associated perforation is presented.

BENIGN NON-TRAUMATIC STRICTURE OF THE LEFT INTRAHEPATIC BILE DUCT . . . . . *Jerome J. Weiner and Samuel LaCorte* 120

A case of benign stricture of the left hepatic duct, non-traumatic in nature, which was demonstrated by postoperative cholangiographic studies.

HYDROCORTISONE IN TENNIS ELBOW . *Irvin Stein, Raymond O. Stein and Martin L. Beller* 123

Five cases of tennis elbow were treated with the local instillation of 25 mg. (1 cc.) of hydrocortisone, with relief in four cases.

Advertising Index on 3rd Cover

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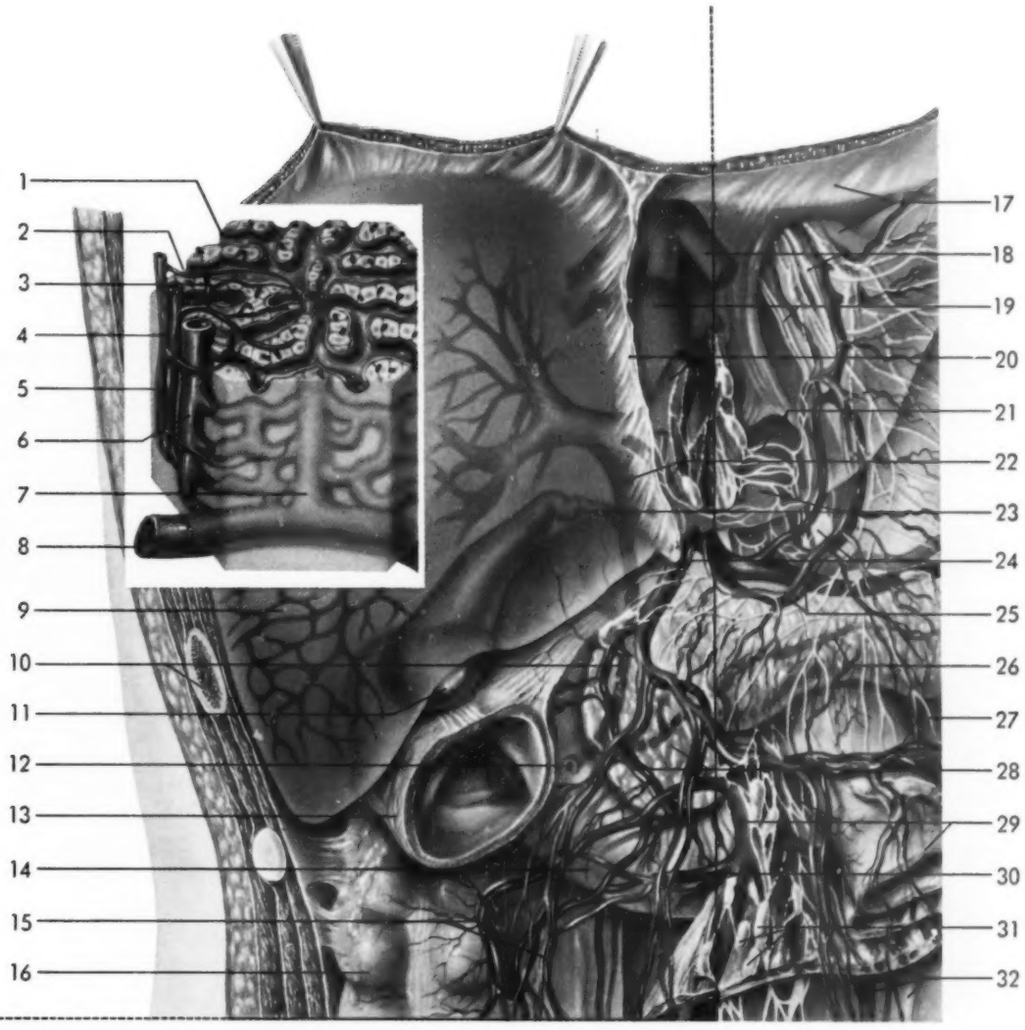

1 Sinusoid
2 Arteriole
3 Bile capillary
4 Branch of hepatic artery
5 Bile duct
6 Branch of portal vein
7 Central vein
8 Branch of inferior vena cava
9 Right lobe of liver
10 Common bile duct and tenth rib
11 Gallbladder
12 Papilla of Vater
13 Transverse colon
14 Duodenum
15 Branches of right colic artery and vein
16 Ascending colon
17 Coronary ligament and esophagus
18 Left hepatic vein and left vagus nerve
19 Inferior vena cava and right vagus nerve
20 Falciform ligament and branch of portal vein
21 Abdominal aorta and celiac plexus
22 Hepatic duct and hepatic artery
23 Cystic duct and celiac artery
24 Celiac ganglion and gastroduodenal artery and vein
25 Left gastric artery and coronary vein
26 Pancreatic duct
27 Right gastroepiploic artery and vein
28 Head of pancreas and pancreaticoduodenal artery and vein
29 Superior mesenteric artery and vein, and jejunum
30 Right colic artery and vein
31 Superior mesenteric lymph nodes
32 Inferior mesenteric vein and left ureter

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2. M. C. Cobey, M.D., F.A.C.S., Professor of Orthopedic Surgery, Georgetown University and Senior Attending Orthopedic Surgeon, Children's Hospital, Washington, D.C., The American Surgeon, Vol. XVIII, No. 4, April, 1952, pp. 413, 415.
3. M. C. Cobey, M.D., F.A.C.S., Washington, D.C., private communication.

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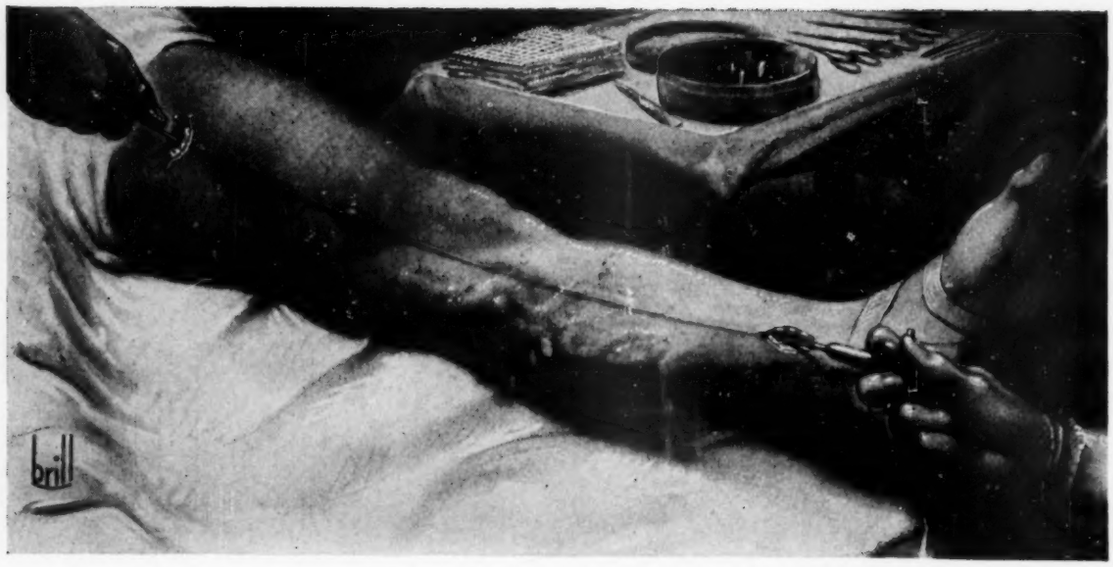

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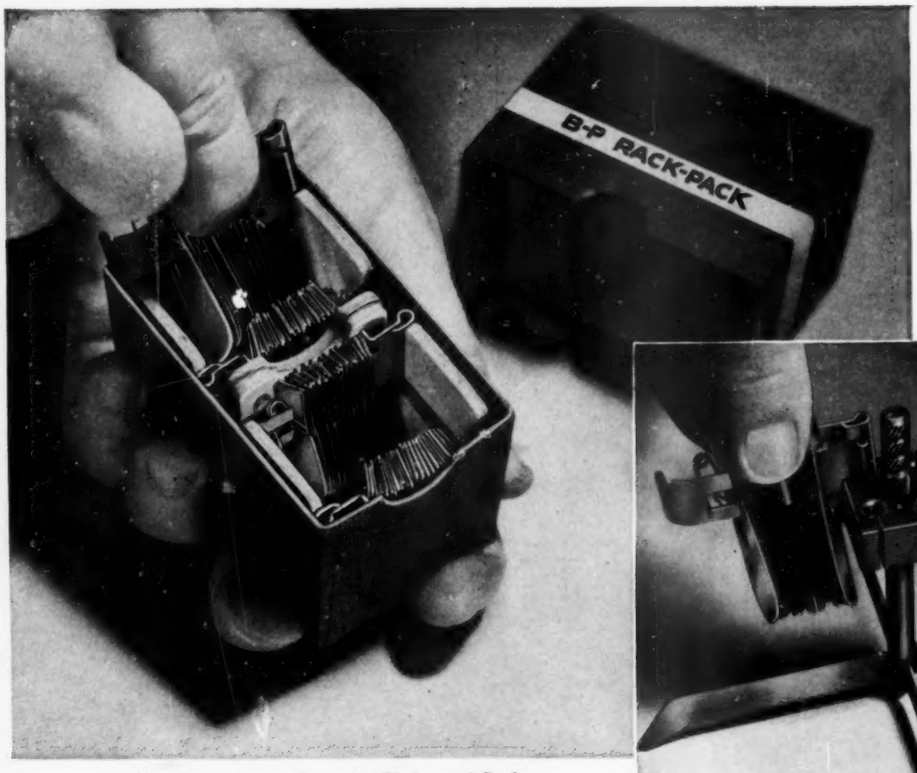


Contains one gross of one size Blades on 4 Racks

RACKS with any size Blades fit the RACK-PACK Stand

A package is known by the COMPANY it keeps . . .

This **B-P RACK-PACK**

of RIB-BACK SURGICAL BLADES

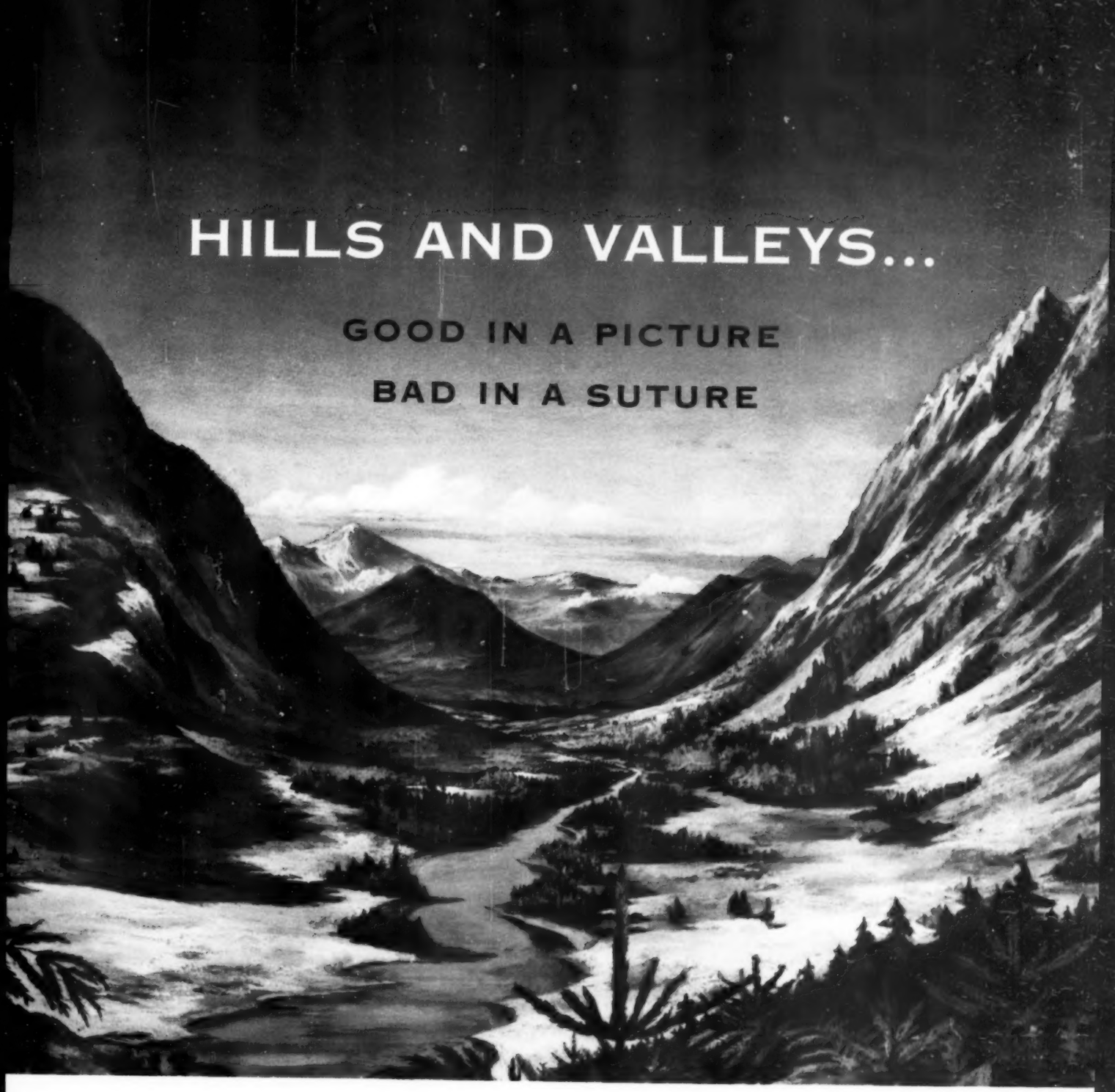
is convincing proof! Just as you can depend upon RIB-BACK Blades to give you maximum cutting efficiency—you can rely on the RACK-PACK package to really save TIME and LABOR for your O.R. Personnel.

NO wrapping of individual packages
NO removing of individual blades
NO handling or racking of individual blades

The RACK-PACK fully protects the perfect cutting edges from damage in shipping, storing and pre-operative handling. V.P.I. rust inhibiting liner prevents corrosion. Blades already on RACK . . . ready for sterilization "*in a matter of seconds.*" AND —it costs the same as conventionally packaged Blades.

Ask your dealer to show you a B-P RACK-PACK today.

BARD-PARKER COMPANY, INC. • **Danbury, Connecticut**



FOR UNIFORM DIAMETER
FROM END TO END

specify **ETHICON®**
tru-gauged catgut

ORDINARY Surface-Chromicized Catgut: microphotograph; stained cross section reveals chrome concentration on outer surface; *inhibits uniform absorption.*

COMPARE

ORDINARY CATGUT WITH

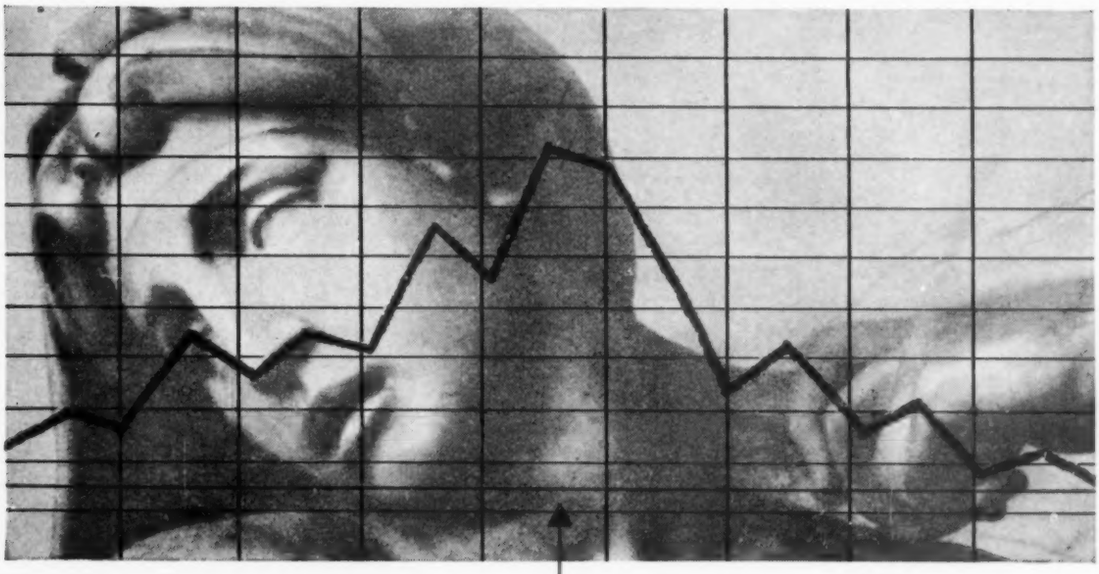
TRU-CHROMICIZED... ETHICON® *catgut sutures*

Even distribution of chrome throughout each ETHICON Tru-Chromicized Suture assures *uniform* absorption, regardless of suture size.

ETHICON Tru-Chromicized Catgut: microphotograph; stained cross section demonstrates even distribution of chrome; *assures uniform absorption.*

ETHICON SUTURE LABORATORIES INCORPORATED NEW BRUNSWICK N.J.

when resistance develops in penicillin therapy...



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BRAND OF CARBOMYCIN

Effective against penicillin-resistant staphylococcal, enterococcal and other streptococcal infections.

A new antibiotic agent for selective use in the practice of medicine today.

Well-tolerated Magnamycin is supplied in sugar coated tablets of 100 mg., bottles of 25 and 100, and 250 mg., bottles of 16.

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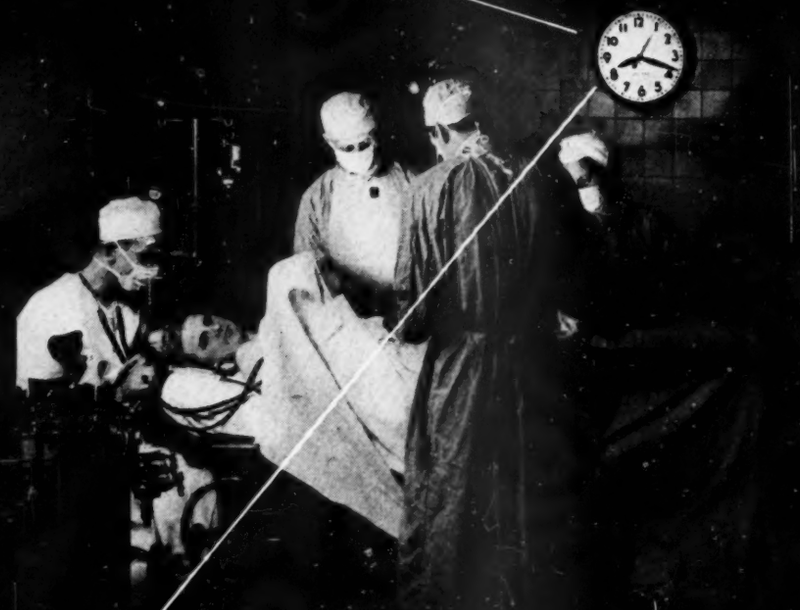
FAST ACTING



added safety for the patient
greater control for the surgeon

In its fast acting control of hemorrhage, KOAGAMIN affords a clearer field for surgery. It reduces bleeding in minutes, regardless of the cause, while Vitamin K, slower in action, is indicated only where prolonged prothrombin time is a factor. When used in conjunction with Vitamin K in such cases, KOAGAMIN effects more rapid control.

PREOPERATIVELY . . . . . minimizes oozing

POSTOPERATIVELY . . . . controls secondary bleeding

THERAPEUTICALLY . . . aids control of internal bleeding

An aqueous solution of oxalic and malonic acids for parenteral use, KOAGAMIN works fast, at a time when speed, safety and control are needed.

Supplied in 10 cc. diaphragm-stoppered vials
Comprehensive dosage chart and literature on request

Chatham

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NEWARK 2, NEW JERSEY, U.S.A.

Available through your Physician's Supply House or your Pharmacist

Reliability . . .

THE PRICELESS QUALITY

BUILT INTO EVERY UNIT

GOMCO EQUIPMENT

GOMCO THERMOTIC DRAINAGE PUMPS

• What is the price of reliability in equipment? When it means a unit ever-ready to do its important job month after month, year after year — a unit you can always count on — then its value to the clinic or hospital is beyond price.

Gomco units have gained this reputation through years of use. Gomco Thermotic Drainage Pumps are widely used in leading hospitals for their gentle, on-off suction so essential in post-operative drainage where delicate tissues must be protected. Automatic, they operate indefinitely without attention other than emptying the gallon suction bottle. A trap bottle protects against overflow damage in the Gomco No. 765 model, while the Gomco No. 765-A has the added protection of Gomco's exclusive Aerovent Overflow Valve. There are no moving parts to wear out or make any noise. Ask your supplier about these investments in gently, completely reliable suction service.

GOMCO SURGICAL MANUFACTURING CORP.

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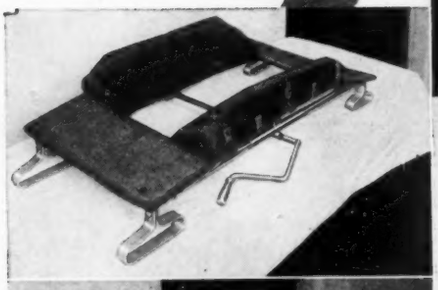
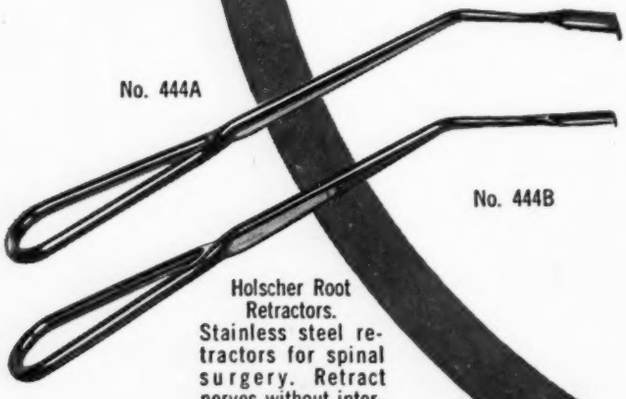
Zimmer TOOLS AND EQUIPMENT FOR SPINAL TREATMENT AND SURGERY



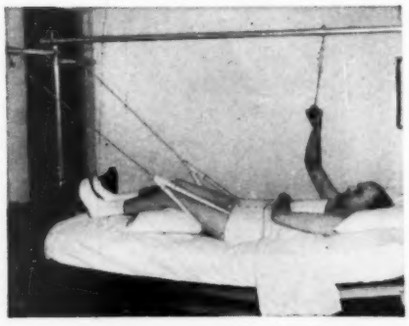
No. 551 Wilson Convex Frame for Spinal Surgery. Positions patient with spine in flexion and with no pressure on abdomen. Adjustable during surgery.



No. 444A

No. 444B

Holscher Root Retractors. Stainless steel retractors for spinal surgery. Retract nerves without interfering with use of rongeurs and other instruments.



No. 649 Pelvic Traction Belt. For treatment of slipped vertebral discs, sprains or minor fractures. Eliminates irritation due to adhesive traction and reduces swelling about knees and ankles.

ZIMMER MANUFACTURING CO. WARSAW, IND.

In Canada Available through selected surgical supply dealers or through our Agents, Fisher & Burpe, Ltd.

Zimmer

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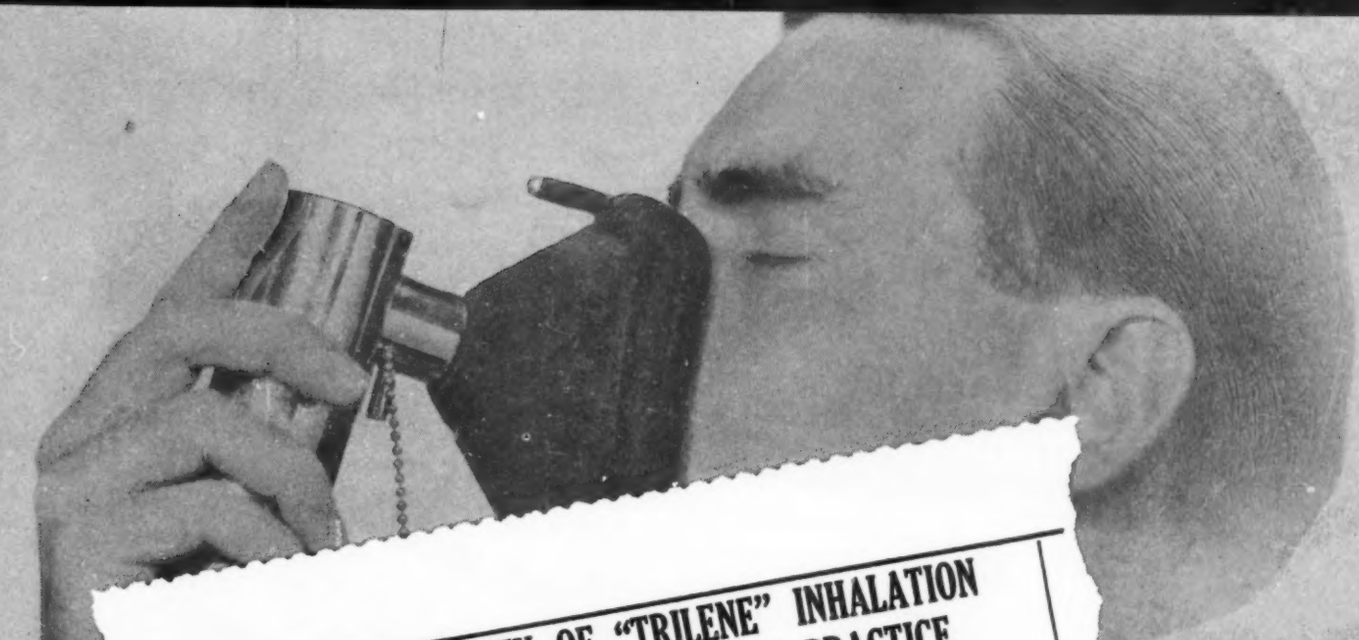


VALUE AND SAFETY OF "TRILENE" INHALATION ANALGESIA PROVED IN UROLOGIC PRACTICE

Study shows self administration with "Duke" University Inhaler has wide application

DURHAM, N. C.—In certain painful urologic procedures, "Trilene," self administered with the "Duke" University Inhaler, safely induces marked analgesia with few if any side effects, and provides convenience of administration, reported Victor A. Politano, M.D. of the Department of Urology, Duke University, Durham, N. C. This paper was recently presented in Havana, Cuba, before the Southeastern Section of the American Urological Association.

In over 100 cases, specially selected because a customarily painful or difficult diagnostic or therapeutic procedure was anticipated, and because "general anesthesia or heavy sedation was not practical or advisable," results with "Trilene" analgesia were described as excellent in 79 cases, and good in 28. Stressing the need for patient cooperation and induction of adequate analgesia, Dr. Politano said "The occasional failures encountered have been due to improper or insufficient instruction in the use of the inhaler and hurried instrumentation before proper analgesia."

These findings add further support to the extensive clinical evidence of effectiveness and safety of self-administered "Trilene" analgesia in obstetrics, as well as in surgical procedures such as the reduction of fractures, incision and drainage of abscesses, removal of painful dressings.

"Trilene," self administered with the "Duke" University Inhaler, will usually provide smooth and rapid induction of analgesia with minimum or no loss of consciousness. Unconsciousness automatically interrupts inhalation. Recovery is rapid, and nausea and vomiting rarely occur.

"Trilene" is nonexplosive, and in the mixtures employed clinically is nonflammable in air and oxygen. "Trilene" may also be used as an analgesic adjunct while light planes of anesthesia are maintained with various anesthetic agents.

"Trilene,"® brand of highly purified trichlorethylene (Blue), is supplied in containers of 300 cc.

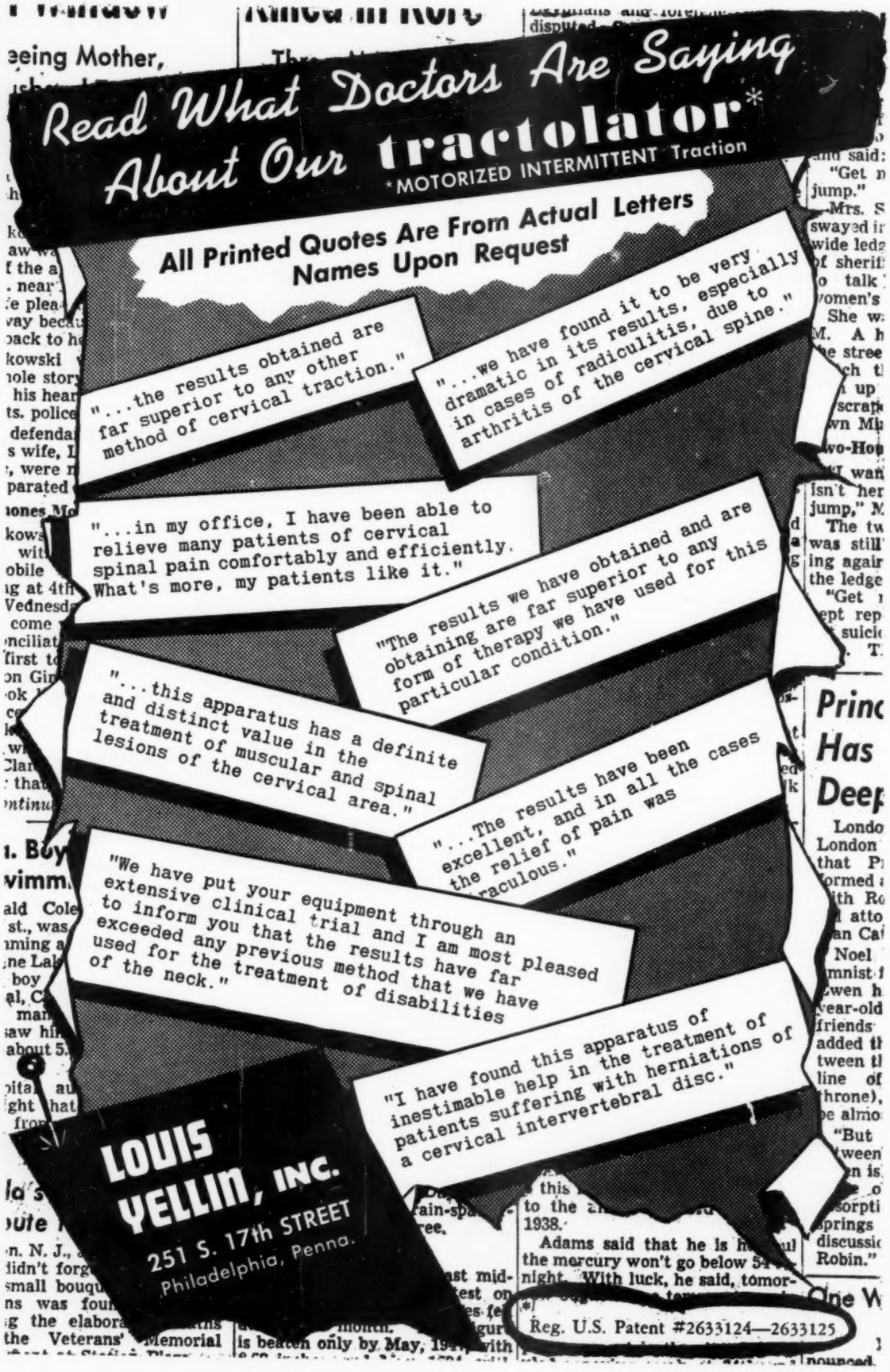
Further information on "Trilene" or the "Duke" University Inhaler (Model-M) may be obtained by writing to Ayerst, McKenna & Harrison Limited, 22 East 40th Street, New York 16, N. Y.

5332

"DUKE" University Inhaler (Model-M)

Recommended for use with "Trilene" in obstetrics and surgery, the "Duke" University Inhaler is specially designed for economy, facility of handling and ready control of vapor concentration. It can be operated with ease and efficiency by adult or child in the doctor's office, in the hospital, in industrial dispensaries, in the home, or even enroute to the hospital.

Ayerst, McKenna & Harrison Limited • New York, N. Y. • Montreal, Canada


Read What Doctors Are Saying About Our tractolator*
*MOTORIZED INTERMITTENT Traction
All Printed Quotes Are From Actual Letters
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"...the results obtained are far superior to any other method of cervical traction."
"...we have found it to be very dramatic in its results, especially in cases of radiculitis, due to arthritis of the cervical spine."
"...in my office, I have been able to relieve many patients of cervical spinal pain comfortably and efficiently. What's more, my patients like it."
"The results we have obtained and are obtaining are far superior to any form of therapy we have used for this particular condition."
"...this apparatus has a definite and distinct value in the treatment of muscular and spinal lesions of the cervical area."
"...The results have been excellent, and in all the cases the relief of pain was miraculous."
"We have put your equipment through an extensive clinical trial and I am most pleased to inform you that the results have far exceeded any previous method that we have used for the treatment of disabilities of the neck."
"I have found this apparatus of inestimable help in the treatment of patients suffering with herniations of a cervical intervertebral disc."
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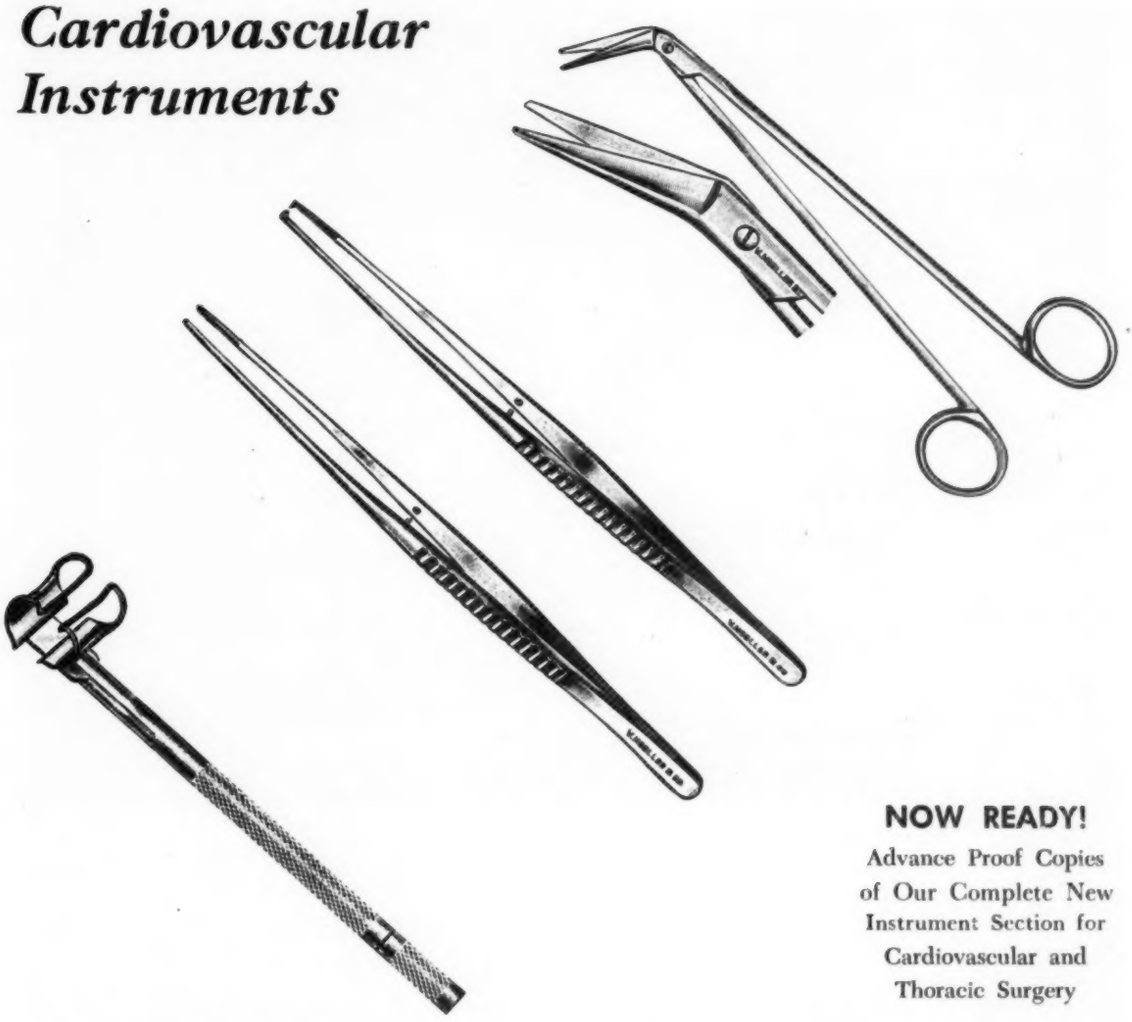
Cardiovascular Instruments



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Advance Proof Copies of Our Complete New Instrument Section for Cardiovascular and Thoracic Surgery

CH-5000 POTTS-SMITH Aorta Clamp. Original model, for anastomosis of the aorta to the pulmonary artery. Large size, 15 mm. x 25 mm. Stainless. Each *$55.00*

CH-5002 Same, medium, 11 mm. x 25 mm. Each *$55.00*

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CH-5170 POTTS-SMITH Dressing Forceps. Delicate, fine serrated tips. 9". Stainless. Each..... *$9.75*

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CH-5660 POTTS-SMITH Scissors. 60-degree angle. Stainless. Each..... *$13.50*

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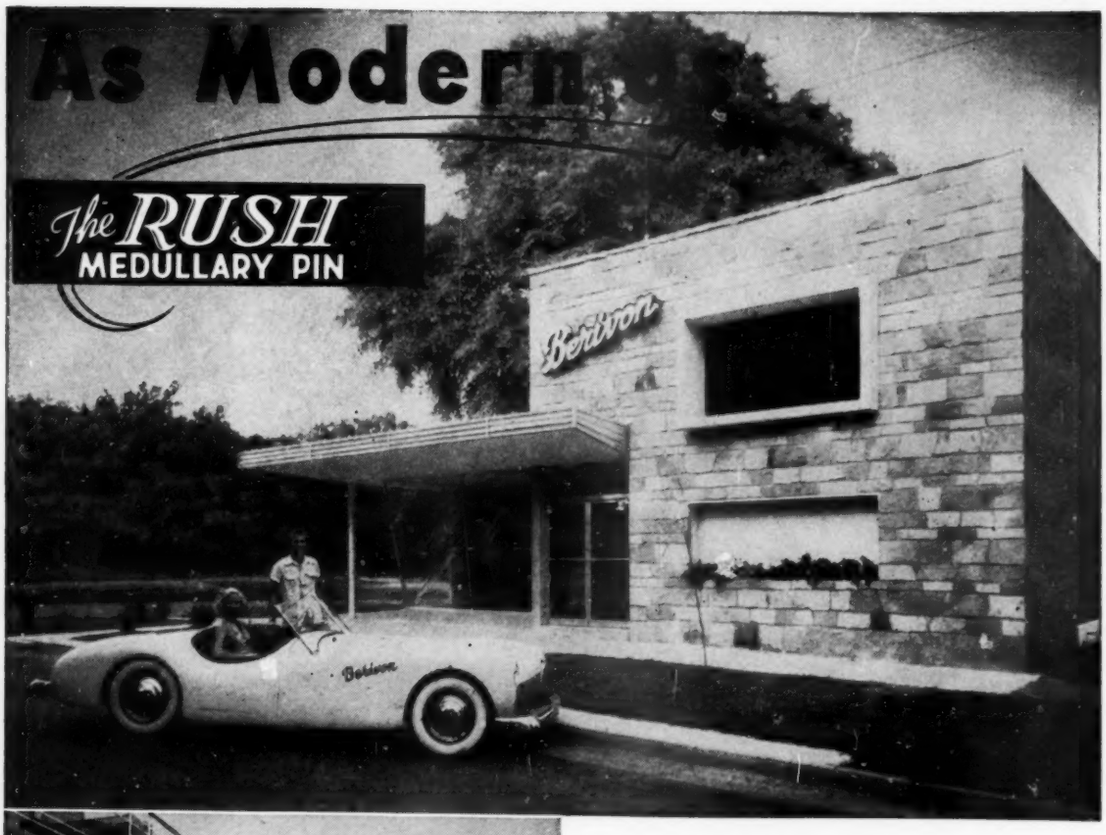
330 SOUTH HONORE STREET **CHICAGO 12, ILLINOIS**



THE BUILDING—
The better to serve you with.

THE SPEEDSTER—
The faster to serve you with.

THE BOY AND GIRL—
Beryl and Vaughn Rush, from whose names the word BERIVON® was derived.

BERIVON® on your pin means:

1. Optimum temper, based on 15 years' clinical research.
2. Minimal tissue irritation.

All Rush pins are hand fashioned of type 316 stainless steel. They are cold worked and electro-polished to remove foreign debris.

The Berivon Company was established for the expressed purposes of safeguarding the quality of the Rush Medullary Pin and for surgical engineering research.

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read Pfizer Spectrum weekly in the J.A.M.A.

to control fulminating sepsis

Intravenous Terramycin therapy in over 100 cases of surgical sepsis following operations of the thorax, abdomen or limbs gave "none but the most favorable results. The well-known side-effects in connection with orally administered antibiotics . . . were never found to occur, nor did we at any time observe any other toxic reactions."

Deucher, F.: Schweiz. med. Wchnschr. 82:1 (Jan. 5) 1952.

broad-spectrum Terramycin Intravenous

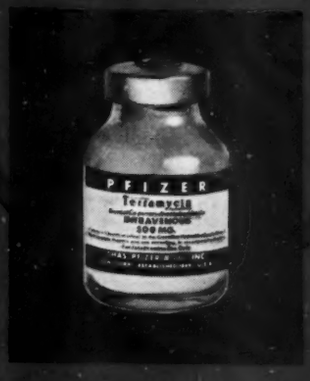
BRAND OF OXYTETRACYCLINE HYDROCHLORIDE

well-tolerated in infants and children

"Our experience with Terramycin by the intravenous route has been good. It has been effectively used without difficulty by continuous drip infusion for several days in the smallest infant . . ."

Farley, W. J., Konieczny, L.: J. Pediat. 42:177 (Feb.) 1953.

Vials of 250 mg. and 500 mg.



as well as adult patients

Intravenous Terramycin, followed by oral therapy after 3-5 days, "is a singly effective, superior antibiotic in the treatment of peritonitis and . . . a good result can frequently be obtained with this drug when [other antibiotics] have failed. It thus has great usefulness both as a primary therapeutic agent and as an alternate antibiotic."

Reiss, E., et al.: A. M. A. Arch. Surg. 64:5 (Jan.) 1952.

Pfizer

Chas. Pfizer & Co., Inc.
Brooklyn 6, N. Y.

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IN
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Meat and its applicability in the Dietary Management of Atherosclerosis

Contrary to the former belief that serum cholesterol levels are primarily related to ingested animal fat and consequently to dietary cholesterol, it now appears that the total amount of fat in the diet, not its source or cholesterol content, is a more important factor in determining the blood cholesterol concentration.[1,2,3,4] Clinical observation has shown that ingestion of vegetable fat—which contains no cholesterol—will, like fats of animal origin, raise the serum cholesterol level.[3, 5]

Recent basic research on the influence of fats and cholesterol on human health has done much to further progress in the fight against atherosclerosis. It will serve well in dispelling the mistaken fear that reasonable amounts of foods of animal origin predispose the individual to this vascular disease.[6] As a matter of fact, a dietary inadequate in essential nutrients but providing too many calories and too much fat from *any* source may well be an important factor underlying the deposition of fat and cholesterol in the arteries and liver.

Cumulative evidence indicates that lowered blood levels of cholesterol may be effected by restricting the total fat intake.[1] Except in instances of refractory hypercholesteremia, in which a daily fat intake as low as 10 Gm. may not reduce cholesterol levels to normal, diets containing 20 to 30 Gm. of fat, or even more, often produce low cholesterol blood levels. In the clinical application of this principle, various palatable, low fat diets which supply three servings of meat daily (containing 18 Gm. of fat) have recently been suggested for the dietary management of arteriosclerosis and for enlisting the cooperation of patients.[1] The meat servings were chosen from a large variety of cuts and kinds of meat (fat trimmed off, as lean as possible). Meat adds to the eating appeal of the fat-restricted diet and contributes important amounts of biologically complete protein, the B group of vitamins including B_{12}, and food iron—all of which are important for a good state of nutrition in the atherosclerotic patient.

1. Hildreth, E.A.; Hildreth, D.M., and Mellinkoff, S.M.: Principles of a Low Fat Diet, Circulation *4*:899 (Dec.) 1951.
2. Bloch, K.: The Intermediary Metabolism of Cholesterol, Circulation *1*:214 (Feb.) 1950.
3. Keys, A.; Mickelson, O.; Miller, E.V.O., and Chapman, L.B.: The Relation in Man Between Cholesterol Levels in the Diet and in the Blood, Science *112*:79, 1950.
4. Gubner, R., and Ungerleider, H.E.: Arteriosclerosis, a Statement of the Problem, Am. J. Med. *6*:60, 1949.
5. Hildreth, E.A.; Mellinkoff, S.M.; Blair, G.W., and Hildreth, D.M.: The Effect of Vegetable Fat Ingestion on Human Serum Cholesterol Concentration, Circulation *3*:641 (May) 1951.
6. King, C.G.: Trends in the Science of Food and Its Relation to Life and Health, Nutrition Rev. *10*:1 (Jan.) 1952.

The Seal of Acceptance denotes that the nutritional statements made in this advertisement are acceptable to the Council on Foods and Nutrition of the American Medical Association.

American Meat Institute

Main Office, Chicago... Members Throughout the United States

Office Management of Leukorrhea with Floraquin®

LEUKORRHEA is commonly caused by vaginitis due to trichomoniasis, moniliasis and senile atrophy. A wet smear examination will establish the cause.

A recommended regimen, especially for *Trichomonas vaginalis* vaginitis, is insufflation with Floraquin powder in the office, accompanied by home treatment with douches of white vinegar solution (1½ ounces per quart of warm water) and insertion of two Floraquin vaginal tablets high into the vagina morning and night. During menstruation treatment is intensified because the pH of the menstrual flow encourages the growth of pathogenic flora. During this period the tablets are used three to five times daily.

If reexamination after three menstrual periods does not show trichomonads on the wet smear, the patient continues to insert Floraquin vaginal tablets only during menstruation[1,2] for several months to prevent reinfection.

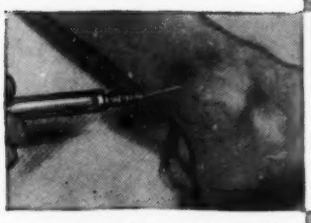
Floraquin is supplied in powder and vaginal tablet dosage forms.

SEARLE *Research in the Service of Medicine*

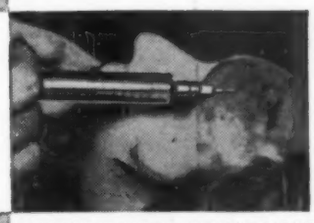
1. Upton, J. R.: Symposium: Certain Aspects of Office Treatment in Obstetrics and Gynecology: Trichomonas Vaginalis Vaginitis, West. J. Surg. *60*:222 (May) 1952.
2. Blinick, G., and Kaufman, S. A.: The Office Management of Leukorrhea, Am. J. Surg. *85*:27 (Jan.) 1953.

WYDASE HAS MANY IMPORTANT ADVANTAGES IN EVERYDAY MEDICAL PRACTICE

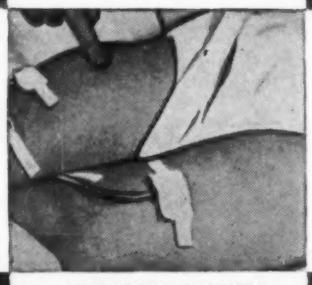
REDUCTION OF SIMPLE FRACTURES



TREATMENT OF SPRAINS



REDUCTION OF HEMATOMAS



HYPODERMOCLYSES

LOCAL ANESTHESIA

HYPODERMAL INJECTION OF CONTRAST MEDIA

Wydase softens tissue hyaluronic acid. This spreads *injected solutions* and *accumulations* of transudates and blood, facilitating their absorption.

Supplied: Vials of 150 and 1500 TR (turbidity-reducing) units.

Wyeth®
Philadelphia 2, Pa.

Lyophilized

Wydase®

Hyaluronidase

Important Note: Wydase is now Council-accepted for use in management of renal lithiasis.

SUSTAGEN

A NEW APPROACH TO TUBE FEEDING

PROTEIN

FAT

CHO

VITAMINS AND MINERALS

A COMPLETE NUTRIMENT EASILY ADMINISTERED BY TUBE

Now for the first time optimum nutrition can be provided *easily* and *acceptably* for patients who cannot or should not take food by mouth. Sustagen and Mead's new Tube Feeding Set eliminate the traditional difficulties and hazards of tube feeding.

WITHOUT COMPLICATING SIDE EFFECTS

The diarrhea, cramps and nausea frequently caused by tube feeding mixtures have been practically nonexistent with Sustagen.

WITHOUT DISCOMFORT TO THE PATIENT

Mead's Tube Feeding Set provides unprecedented ease and convenience of administration. The extremely small, smooth plastic tubing, about half the size of the smallest rubber tube, is easily inserted and swallowed almost without sensation.

IDEAL ALSO FOR ORAL USE

Sustagen provides a pleasant-tasting, nutritious, well tolerated drink. A glassful made with 3 ounces Sustagen and 5 ounces water supplies 330 calories and 20 Gm. protein.

a 24 hour feeding of 900 Gm. supplies:

Calories	**3500**
Protein	**210 Gm.**
Fat	**30 Gm.**
Carbohydrate	**600 Gm.**
Vitamins and Minerals	
Vitamin A	5000 units
Vitamin D	500 units
Ascorbic acid	300 mg.
Thiamine hydrochloride	10 mg.
Riboflavin	10 mg.
Niacinamide	100 mg.
Calcium pantothenate	40 mg.
Pyridoxine hydrochloride	5 mg.
Choline bitartrate	500 mg.
Folic acid	2.5 mg.
Vitamin B_{12} (crystalline)	4 mcg
Iron	15 mg.
Calcium	6.3 Gm.
Phosphorus	4.5 Gm.
Sodium	1.9 Gm.
Potassium	7 Gm.

Sustagen contains powdered whole milk, non-fat milk solids, calcium caseinate and Dextri-Maltose plus vitamins and iron.

SUSTAGEN

For detailed information, write for the booklet "How to Use Sustagen."

MEAD

MEAD JOHNSON & COMPANY • EVANSVILLE 21, INDIANA, U.S.A.

7:45 A.M. Room A Suprapubic

8:00 A.M. Ampitheatre Cholecystec

8:00 A.M. Room B Thyroidecto

8:15 A.M. Room C Radical Mas

8:45 A.M. Room A2 Submucous R

9:30 A.M. Ampitheatre Resection o

useful throughout the operative schedule

Thrombin Topical

THROMBIN TOPICAL acts directly on the blood fibrinogen to form a firm, adherent, *natural* clot, producing hemostasis in a matter of seconds. Whether you spray, flood or dust it onto affected surfaces, **THROMBIN TOPICAL** helps control capillary bleeding in abdominal surgery, brain and bone surgery, skin grafting, nose and throat operations, prostatic surgery, dental extraction, bleeding incident to drainage, excision or debridement, and many other operative procedures.

THROMBIN TOPICAL (bovine origin) is supplied in vials containing 5000 N.I.H. units each, with one 5-cc. vial of sterile isotonic saline diluent. Also available in a package containing three vials of **THROMBIN TOPICAL** (1000 N.I.H. units each) and one 6-cc. vial of diluent.

THROMBIN TOPICAL should never be injected. It is intended for topical use only.

MEDICAMENTA VERA PD & CO.

Parke, Davis & Company
DETROIT, MICHIGAN

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Sadove, M. S., Nelson, J. T., and Unna, K. R.: Comparative Evaluation of Curare-Like Drugs, Current Res. in Anesth. & Analg., *30*:221, 1951.

*"Metubine Iodide," supplied as dimethylether of *d*-tubocurarine iodide, was used in this study.

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Editorial

SURGICAL TREATMENT OF CANCER OF THE CERVIX

IN view of the renewed interest in the surgical treatment of cancer of the cervix and the fact that results of this treatment will be carefully scrutinized for comparison with results achieved by radiation, it becomes necessary to define rather sharply what should be meant by "surgical treatment." For years this was synonymous with the "Wertheim operation." In modern terms the latter operation is not a radical one. Wertheim, by his own statements, did not perform routinely a pelvic lymph node excision. His position was that individual lymph nodes could be excised for histologic study in order to aid in prognosis, for he believed that once pelvic lymph node metastases occurred the patient was lost. As early as 1895 J. G. Clark, then resident surgeon to Howard A. Kelly, published a report on excision of pelvic nodes together with a radical hysterectomy. A study of the illustrations accompanying that article shows that the cluster of glands about the bifurcation of the common iliac vessels were the only ones removed. Also, at the end of the nineteenth century Ries published an article comparing the surgical problem of cancer of the cervix in relation to the pelvic nodes with cancer of the breast in relation to the axillary nodes, but he did not cite a series of patients operated upon. A few years later Latzko described radical panhysterectomy with extensive pelvic node excision but the mortality of such a procedure in those days was prohibitive to the point that no surgeon reported sufficient cases to permit an evaluation of the operation. It is interesting to note that in the beautifully illustrated texts by Peham and Amreich, Latzko's operation is illustrated in detail, but again there are no statements as to who might have performed sufficient numbers of the operation to permit an authoritative estimate of its value.

In order to reduce mortality and morbidity Schauta devised and carried out a radical vaginal hysterectomy, removing portions of parametria and paracervical tissue. He and his pupils and their students have since performed many hundreds of these operations. Today, Mitra in Calcutta, Navratil in Graz, Bastianeese in Amsterdam, and others especially in Central Europe continue to carry out this procedure, at least in certain instances. Its main advantage is that it is a safe procedure that carries little risk of morbidity and mortality. Its principal disadvantage is the failure to deal with the pelvic lymph nodes, and its usefulness is limited to small growths.

In England Victor Bonney carried out what he called "Wertheim's operation," but in reality this was a more extended procedure because the nodes about the external iliac vessels and in the obturator spaces were also removed.

Taussig performed pelvic lymph adenectomy in association with radiation therapy to the cervix. The latter was left *in situ*. From his writings and the accompanying illustrations, the lymphadenectomy consisted principally of removing individual or small groups of nodes separately, with little emphasis on a wide *en*

bloc excision of nodes and surrounding fatty tissues and pelvic peritoneum. The extraperitoneal lymphadenectomy described by Taylor and Nathanson is a procedure directed to ablation of the lymph nodes in the lateral retroperitoneal spaces of the pelvis and does not represent a radical surgical attack upon the primary lesion and its lymph node areas *en masse*.

Meigs in 1939 envisaged a "combination of the Wertheim hysterectomy and Taussig's node dissection . . . the routine removal of all nodes small or large from the common iliac artery, along the external iliac arteries, into the obturator foramen with exposure of the obturator nerve and the removal of as much parametrium and vagina as possible." Of necessity, because the standard treatment of cervical cancer was by radiation, the initial attempts by Meigs were carried out in highly selected patients to reduce the likelihood of mortality and avoid, as much as possible, morbidity. As time goes on selection of patients by him has been progressively diminished, with increase in radicality of the operation.

In "radical panhysterectomy and pelvic node excision" which the writer has been carrying out for over five years a complete skeletization of the pelvis is envisaged in which all nodes, fatty tissues and vessels are removed; the structures remaining are: the ureters, with what appears to be sufficient areolar tissue about them to preserve circulation; the bladder, with posterior and lateral walls denuded; the rectal colon; the obturator nerves and the external iliac vessels. The sciatic nerve trunks are laid bare, the musculofascial pelvic floor is completely exposed and only the lower third or less of the vagina is preserved. All the peritoneum is likewise excised except that over the dome of the bladder and over the lower sigmoid colon and its mesentery. Reperitonealization is not performed. Vaginal function is generally not impaired by this procedure.

Added to the foregoing discussion of the various forms of surgical attack upon cancer of the cervix are the procedures of anterior partial pelvic exenteration and total pelvic exenteration for the desperate situations.

Thus in the surgical treatment of cancer of the cervix there is a variety of procedures and results will have to be expressed in terms of these procedures as well as in terms of extent of disease and selection of patients operated upon. It is obvious, from what is known of the mode of spread of cancer of the cervix to pelvic lymph nodes, that a simple total hysterectomy cannot suffice and that even the classic Wertheim operation does not afford a maximal surgical effort. The surgeon envisaging a surgical attack upon cancer of the cervix should be fully cognizant of the technical details associated with panhysterectomy and lymph node excision and must be prepared to cope with bladder, ureteral and bowel injuries at operation and with the management of complications, especially those of the urinary tract, after operation.

ALEXANDER BRUNSCHWIG, M.D.

Original Articles

FREEZE-DRIED AORTIC GRAFTS*

A PRELIMINARY REPORT OF EXPERIMENTAL EVALUATION

LIEUT. JAMES W. PATE, M.C. AND LIEUT. PHILIP N. SAWYER, M.C.

Bethesda, Maryland

A DETAILED experimental evaluation of freeze-dried aortic grafts in dogs is under way. The first seventy homografts completed form the basis for this preliminary report.

Homologous arterial grafts have been used with acceptable results in a variety of diseases in man. One of the most serious problems incident to the use of vascular grafts has been the lack of a satisfactory method of storage for the grafts from time of donation to the time of use. Several methods have been used with varying success. These have included formalin and alcohol fixation; storage in gases, petrolatum and nutrient media at near-freezing temperatures; and quick-freezing with storage well below the freezing point.[1–23] All of these methods are unsatisfactory because of poor clinical results, limitations of storage time or the complicated, expensive technical care required during storage which prohibits stock-piling of the vessels.

Hyatt and associates have reported good results using freeze-dried tissues as grafts in both animal and man.[24–28] In 1950 Marrangoni reported the use of freeze-dried arterial segments with encouraging results.[29,30] Freeze-drying has several theoretic advantages over the other methods of storage.

Freeze-dried tissues are believed to be completely dead. Carrel in his classic work indicated that tissues must be alive for satisfactory transplantation. This belief has been widely circulated by many subsequent investigators. However, it has been repeatedly observed that homografts slough or die and are replaced after grafting even though they may survive and proliferate for short periods of time. In fact, with the exception of a few cases in identical twins, there are no valid reports of permanent survival of mature homologous tissue after implantation in its normal site. Therefore we cannot assume that it is necessary to have viable transplants if they serve only a simple mechanical function. Furthermore, from a theoretic standpoint, the presence of injured living cells may be deleterious. These cells may give off metabolites and toxic products of degeneration which may be actually harmful. These products may add to the incidence of autolysis, thrombosis and surrounding tissue reaction, with resultant weakness of the suture lines and increased amounts of scarring. There are certain experimental data to support this point of view.[31,32] The requirements for a satisfactory arterial graft are simple: A graft should transmit an adequate amount of blood for as long as desired without leakage and without producing other undesirable effects. If these requirements are fulfilled, the question of viability is considered purely academic.

Freeze-drying may allow longer periods of storage at room temperature without special care, routine shipment from the point of processing to the point of subsequent use, and stock-piling. In view of these theoretic advantages a more complete experimental evaluation of freeze-dried arteries has been undertaken.

Plan of Project. The phase of the project reported herein is concerned only with homologous aortic transplants in adult male dogs.

* From the Naval Medical Research Institute and Tissue Bank, Naval Medical School, National Naval Medical Center, Bethesda, Md. The opinions or assertions contained herein are the private ones of the authors and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

The abdominal aorta between the renal arteries and trifurcation was used in all cases. No anticoagulants or special diets were used.

The dogs were divided into two groups, namely, those which received freeze-dried homografts, and those which received fresh homografts, the latter group acting as controls. The two most important variables with which this project is concerned are (1) the length of time grafts may be stored and yield acceptable clinical results when implanted and (2) the anatomic and physiologic condition of the grafts at various periods of time after implantation. The schedule of the investigation is shown in Table 1.

TABLE 1
SCHEDULE FOLLOWED IN STUDYING THE FATE OF HOMOLOGOUS AORTIC GRAFTS IN DOGS

Time Elapsed after Implantation before Sacrifice (wk.)	Freeze-dried Grafts							Fresh Grafts
	Time Grafts Stored (wk.)						Total	
	1	6	12	25	52†	104†		
1	2	2	2	2	2	2	12	2
6	2	2	2	2	2	2	12	6
12	2	2	2	2	2	2	12	5
25	2	2	2	2*	2	2	12	3
52	2*	2*	2*	2*	2	2	12	3*
104	2*	2*	2*	2*	2	2	12	3*
	12	12	12	12	12	12	72	22

* Observation periods for these dogs not yet completed; at time of writing these dogs were all alive and well.

† These cases not included in this report.

MATERIALS AND METHODS

Donor aortic grafts were removed under sterile technic from dogs either before or immediately after death. They were washed in saline containing penicillin (400 units per cc.) and streptomycin (400 units per cc.). They were immediately placed in ampuls partially submerged in liquid nitrogen at −196°C. and quick-frozen. Quick-freezing was used in an effort to decrease crystal formation, electrolyte concentration and possible protein denaturation, which result in destruction of the normal cellular architecture.[33–36] These adverse phenomena occur at a rate that is directly proportional to the temperature and the length of time involved in the freezing process. While still at this low temperature the grafts were placed under a vacuum of 50 to 20μ Hg pressure in a modification of a commercial freeze-drying machine. The water was sublimated from the ice to the vapor stage without passing through a liquid phase, thereby markedly reducing the undesirable effects previously mentioned. The tissues were then allowed to warm to room temperature while being maintained under a vacuum of at least 50μ Hg pressure. Removing heat of sublimation by evaporation kept the tissues frozen during the early stages of dehydration. The vacuum was maintained for seventy-two hours, during which time the temperature slowly rose to 20°C. The tissues were then removed and sealed in glass ampuls under a pressure of about 100 to 200μ Hg. The vacuum sealing was used in an effort to exclude oxygen and water since we believe exposure to these agents causes deterioration of the grafts during long periods of storage.

The ampuls, with their grafts, were stored at room temperature. During and at the end of the period of storage the ampuls were tested for vacuum using a high frequency spark. The ampul was broken at the time of implantation and the graft placed in normal saline for twenty to thirty minutes for reconstitution. At this time the microscopic sections and physical properties were essentially the same as those of fresh aortic tissue. (Fig. 1.)

The grafts were implanted in the abdominal aorta of dogs under intravenous sodium pentobarbital anesthesia. A left transrectus incision was made, the viscera were packed off and the aorta was dissected free from the level of the left renal artery to below the trifurcation. The deep iliac circumflex arteries, the inferior mesenteric and two to three pairs of the most caudal lumbar arteries were ligated and divided. Potts ductus arteriosus clamps or rubber shod Carmalts were applied to the aorta 6 to 7 cm. apart. A segment of vessel from 1 to 3 cm. long was then removed with a sharp scalpel. The length of the segment to be removed was determined by the mobilization and elasticity of the aorta in an effort to place essentially the same tension on the suture lines in all grafts.

The graft was implanted with an everting

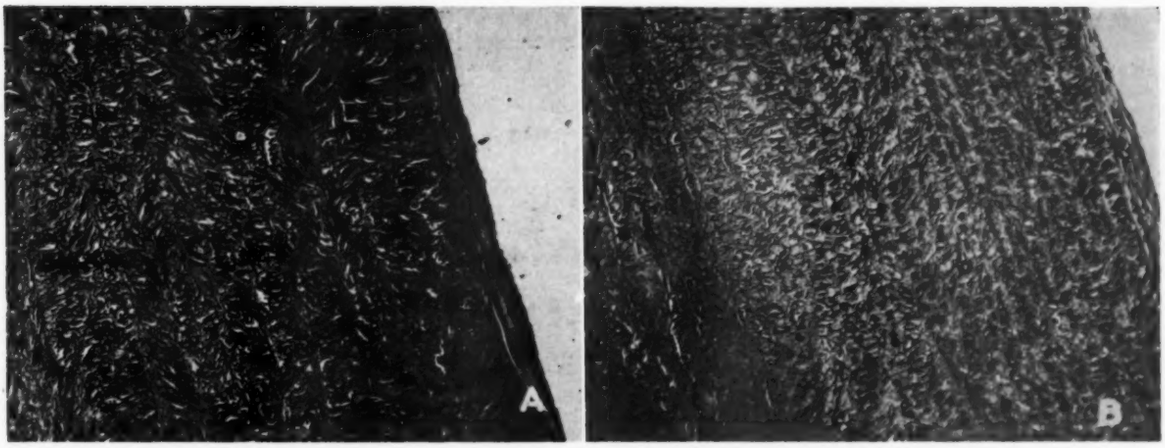

FIG. 1. A, aorta immediately after removal from the animal; B, same aorta as (A), reconstituted, after freeze-drying and storage at room temperature for six months. Hematoxylin and eosin stain.

continuous mattress suture of No. 5–0 or No. 6–0 twisted silk on an atraumatic needle. The lower clamp was removed first and the oozing from the needle holes stopped by the application of pressure. The upper clamp was then removed slowly over a period of one minute. The vessel was not reperitonized.

The abdomen was closed in layers using cotton sutures. A small dry dressing was applied with collodion. Each animal received one intramuscular dose of 300,000 units of procaine penicillin at the end of the operation.

The animals were examined frequently for skin color, temperature, femoral pulsations and gross neuromuscular function of the hind legs.

Aortagrams were done each three months on the longer term animals. Twenty-five cubic centimeters of 70 per cent diodrast were injected through a No. 13 trocar inserted into the right external jugular vein. The x-ray was taken six seconds after the injection.

At the time of sacrifice the animals were anesthetized with intravenous sodium pentobarbital. The abdomen was opened and pulsations of recipient aorta and graft observed and graded as 0 to 4 plus. The amount and texture of the reaction surrounding the graft was noted. A small plastic catheter was inserted through a side branch and passed into the graft. This was used, in conjunction with an electrode on the outside of the vessel, to measure the electric potential of the graft and the normal aorta.

A No. 18 trocar with the lumen opening at a right angle to its long axis was passed into the side branch after removal of the catheter. Another trocar with its lumen opening on the side parallel to its long axis was also inserted into the aorta. The trocars were advanced until one-fourth of their length lay in the aortic lumen. These trocars now comprised a Pitot tube system and were connected to a differenential manometer. The reading on the manometer was proportional to the velocity of the blood flow. This allowed calculation of the mean blood flow.[37] The method was not highly accurate due to several factors. However, in calibration tests with varying flow rates, resistances and vessel sizes, the technic was accurate to within 200 cc. per minute. This is considered accurate enough for the purposes of this investigation.

After these observations the lower abdominal aorta with its graft was resected, incised longitudinally and gently washed in normal saline. The gross appearance was noted and the specimen usually photographed. (Fig. 2.) A strip of graft 2 cm. long (including one suture line) with a cross sectional area of 3 mm^2. was excised for elasticity and tensile strength studies.

The graft strip was placed in an apparatus which applied tension to the graft by adding weight in the form of distilled water at a constant rate of 100 gm. per minute for two minutes. The slow rate of stretch was used so as to minimize and standardize the effects of hysteresis. A 23.3:1.0 magnifying arm wrote on a kymograph drum. The resultant tension versus elongation curve was analyzed.[38–42] This simple method was permissible for these purposes since it has been shown that the elasticity characteristics of the aorta are comparable when measured longitudinally or where measured circumferentially.[42] Excluding the first curve on each graft, which probably de-

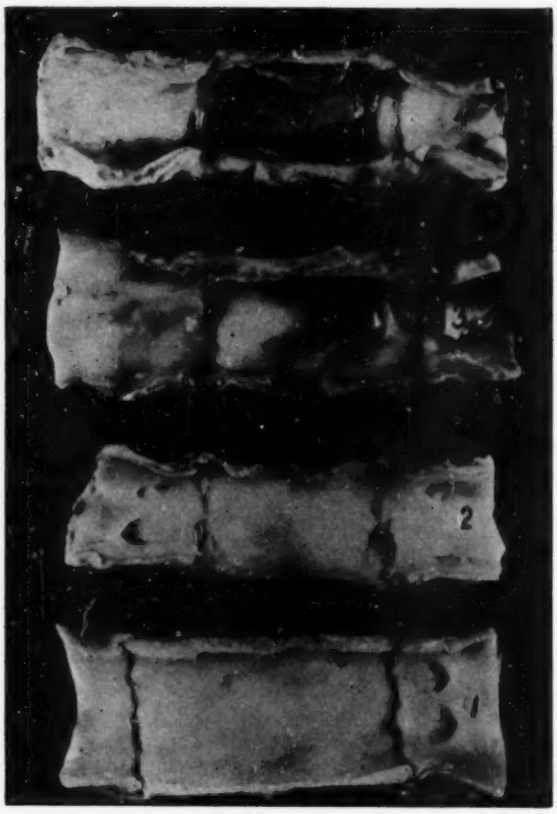

FIG. 2. (1) Freeze-dried aortic graft stored for three months and implanted for six months; (2) fresh aortic graft three months after implantation; (3) freeze-dried aortic graft (poor result) stored for three months and implanted for three months; (4) fresh aortic graft (poor result) implanted for three months.

pends upon the vascular tonicity at the time of death, the apparatus obtains reproducible curves (on the same specimen) which vary less than 0.08 mm., giving a reliability of approximately 1 per cent. This allows good comparison between curves from various vessels.

A similar apparatus, using mercury in increments of 0.675 gm., was used to determine the breakage point. The results are expressed in gm./cm^2. of cross sectional area of the vessel.

The remainder of the graft was fixed in Bouin's solution and preserved in 85 per cent alcohol. Portions of it were used in making hematoxylin and eosin, trichrome and elastic tissue stains on microscopic sections. Numerous sections were taken through each graft. Most of these are longitudinal, from the center of the graft through the suture line, including a portion of the normal aorta for comparison.

The foregoing studies were also done on a specimen from each donor artery. This allowed a detailed study of the changes which take place in the graft during and after processing, after various periods of storage and after reconstitution. This provided a basis for evaluating the phenomena which occur after implantation into animals for various periods of time.

TABLE II
ANALYSIS OF CLINICAL RESULTS IN THE EXPERIMENTAL ANIMAL

Type of Graft	Fresh	Freeze-dried	Totals
No. of cases	22	48	70
Mortality	3 (13.6%)	1* (2%)	4
Thrombosis			
(a) No or slight encroachment on lumen	3 (13.6%)	1 (2%)	4
(b) Serious encroachment on the lumen	2 (9.1%)	0	2
(c) Total	5 (22.7%)	1 (2%)	6
Hemorrhage	2 (9.1%)	1* (2%)	3
Results of grafts			
(a) Excellent	12 (54.6%)	46 (96%)	58
(b) Good	2 (9.1%)	0	2
(c) Poor	1 (4.6%)	1 (2%)	2
(d) Failure	4 (18.2%)	1* (2%)	5
(e) Inadequate follow-ups	3 (13.7%)	0	3

* Same case; graft was not stored under a vacuum.

To date forty-eight freeze-dried arteries have been implanted for this study. Twelve of these were stored for one week before implantation, twelve were stored for six weeks, twelve for three months, and twelve for six months. Twenty-two fresh grafts have been implanted for controls. All long term fresh grafts have been followed up for at least five months. Follow-ups on the freeze-dried grafts have been for from one month to fourteen months with a man of 6.8 months. (Table 1.)

RESULTS

The results have been classified and partially analyzed in Table II. It is seen from this table that freeze-dried grafts, even when preserved for as long as six months, show a significant reduction in mortality compared to fresh grafts (2 per cent versus 14 per cent); decrease in incidence and degree of thrombosis (2 per cent versus 23 per cent); and unsatisfactory results (4 per cent versus 23 per cent). Overall, freeze-dried grafts are superior to fresh homologous grafts with 96 per cent of freeze-dried grafts classed as excellent and 55 per cent of fresh grafts classed as excellent. The freeze-dried grafts may be even better because the one case showing failure, hemorrhage and death might have been prevented. This graft

was known to have a poorer vacuum during its storage period than is recommended, but was implanted to observe its biologic fate. Vessels which have been stored under a poor vacuum are friable and have poor physical and histologic characteristics.

TABLE III
EFFECTS OF STORAGE PERIODS OF GRAFTS ON RESULTS AFTER IMPLANTATION

Storage Time (wks)	No. of Grafts	No. Still Alive	Unsatisfactory Results	Satisfactory Results	Excellent Results
1	12	4	0	1	11
6	12	4	0	0	12
12	12	6	1	1	11
25	12	6	0	0	12
Totals	48	20	1	2	46

The elasticity studies have shown that there is essentially normal elasticity in the physiologic blood pressure range for at least six months after implantation. There is some limitation of elasticity at higher tensions. These results will be reported in detail later.

The tensile strength of the graft is quite adequate for physiologic requirements. When expressed as a function of cross sectional area the tensile strength of the graft is actually higher than that of a normal aorta. This is an apparent rather than real difference since there is a marked thinning of the vessel wall with degeneration of the weaker muscle cells, leaving only the stronger elastic fibers. It is interesting to note that at autopsy after more than two weeks of implantation the grafts invariably break in their center portion rather than at their suture lines.

There has been only one animal in the group which showed significant decrease in blood flow. In this instance there was about 70 per cent reduction in flow but no clinical signs of ischemia in the hind limbs.

Aortagrams were valuable in that they confirmed the physical findings and helped to predict the postmortem observations. Most of the plates showed visible suture lines with some narrowing there, but no abnormalities of the grafts and adequate dye flow distal to the graft site.

The bio-electrical studies confirmed the concept of death of the grafts and also offered explanation for the better results with dead than with living tissues. These investigations will be reported separately.[31,32]

Table III shows a tabulation of the effects of various storage times on the results after implantation. It is seen that there is no significant difference in the results obtained with grafts preserved for one, six, twelve or even twenty-five weeks. This conclusion is confirmed by the physical studies.

TABLE IV
SUMMARY OF MICROSCOPIC OBSERVATIONS IN FREEZE-DRIED AND FRESH AORTIC GRAFTS

Phenomena	Survival Period (wks)	Freeze-Dried Grafts (Averages)	Fresh Grafts (Averages)
I. Suture line healing (0–4–)	1	2.5+	0.5+
	6	2.8+	2.0+
	12	4.0+	4.0+
	25	4.0+	4.0+
II. Re-endothelialization (mm. in length from each suture line)	1	1.0 mm.	0.2 mm.
	6	8.6 mm.	4.6 mm.
	12	9.2 mm.	9.6 mm.
	25	Complete (11.0 mm.)	Complete (11.0 mm.)
III. Muscle degeneration (0–4–)	1	3.7+	0+
	6	3.8+	2.5+
	12	4.0+	3.0+
	25	4.0+	4.0+
IV. Elastic fiber survival	1	95%	95%
	6	85%	86%
	12	80%	79%
	25	80%	81%
V. Reaction (0–4–)	1	1.5+	3.8+
	6	0.8+	3.1+
	12	0.2+	1.8+
	25	0.3+	1.5+

Histologic Studies. The sequence of histologic events is essentially the same in both the fresh and freeze-dried grafts. However, there are several differences in the rate of occurrence of some of these changes. Hematoxylin and eosin, trichrome and elastic tissue stains were done on each graft. All slides were assigned code numbers and evaluated without knowledge of the length of time of implantation or the type of graft. After evaluation they were classified according to the type of graft and the length of the postoperative period before autopsy.

The suture lines are healed by an ingrowth of fibroblasts from the normal aorta into the

FIG. 3. Intimal degenerative changes in a fresh aortic graft. (Unusual occurrence.) Hematoxylin and eosin stain.

end of the graft, with the media contributing the least number of cells and the adventitia the most. On all the slides the suture line healing was graded as 0 to 4 plus, depending upon the amount of fibrous union seen. One week postoperatively the freeze-dried grafts averaged 2.5 while the fresh averaged 0.5. Six weeks postoperatively the freeze-dried had a mean of 2.75, the fresh 2.0. At twelve weeks all the grafts in each group appeared to be completely healed. It seems that the freeze-dried grafts may heal faster during the early stages than do the fresh grafts. (Table IV, section I.)

The rate of re-endothelization was one of the most interesting phenomena observed microscopically in this series. The distance that the endothelium had grown in from the suture line was measured under a microscope on each separate slide. Table IV, section II, shows the amount of re-endothelization in each type of graft for each postoperative time period. It is seen that there is apparently faster re-endothelization in the freeze-dried than in the fresh grafts. This is especially evident after the first six weeks when the rate of freeze-dried grafts is 1.5 mm. per week and for the fresh grafts 0.8 mm. per week.

There is a slight tendency for the fresh grafts to have a thicker intima than the freeze-dried grafts, with a mean difference of 12.4 per cent. There were three cases (14 per cent) in this series of fresh grafts which showed varying amounts of intimal degeneration. Thickening of the intima occurred consisting of fibroblasts and deposition of lipoid and cholesterol crystals. These areas of lipoid deposition consisted of small plaques, usually 2 to 3 mm. in diameter, scattered over the surface of the intima. One of these showed a small area of calcification. (Fig. 3.) This intimal degeneration was seen in no case of freeze-dried grafts.

Muscle degeneration occurred much faster in the freeze-dried than in the fresh grafts. (Table IV, section III.) All visible muscle cells were usually absent in the freeze-dried grafts after one week. The fresh grafts, however, frequently showed remarkably well preserved cellular details at one week and usually showed a fair number (mean 37.5 per cent) of cells six weeks postoperatively. (Fig. 4.) The mechanism of removal of these cells could not be clearly defined but the pattern of removal showed some differences in the two types of grafts. Phagocytes were seen only occasionally; the cells appeared to be destroyed by lysis. In 33 per cent of the fresh grafts the muscle cells toward the intima persisted longer than the other cells; the muscle cells toward the outside of the vessel persisted longest in 25 per cent of the grafts and in the remaining 42 per cent it appeared that there was diffuse lysis of the cells. (Fig. 4.) In contrast the muscle cells in most of the freeze-dried grafts (92 per cent) had so completely disappeared, even as early as one week, that evaluation of the site of removal was not possible.

The elastic fibers are apparently the only portions of aortic grafts which remain indefinitely after implantation. All the grafts in this series showed persistence of intact elastic fibers. Many of these fibers appeared thicker than normal, some as much as twice the thickness of the fibers in the sections on the same vessel before implantation. (Fig. 5.) No definite fragmentation was observed although this is extremely difficult to evaluate. Three elastic fiber counts were made on each of twelve cross sectional segments of each vessel while fresh, after freeze-drying and storage, and at various periods of time after implantation. The counts on each vessel were

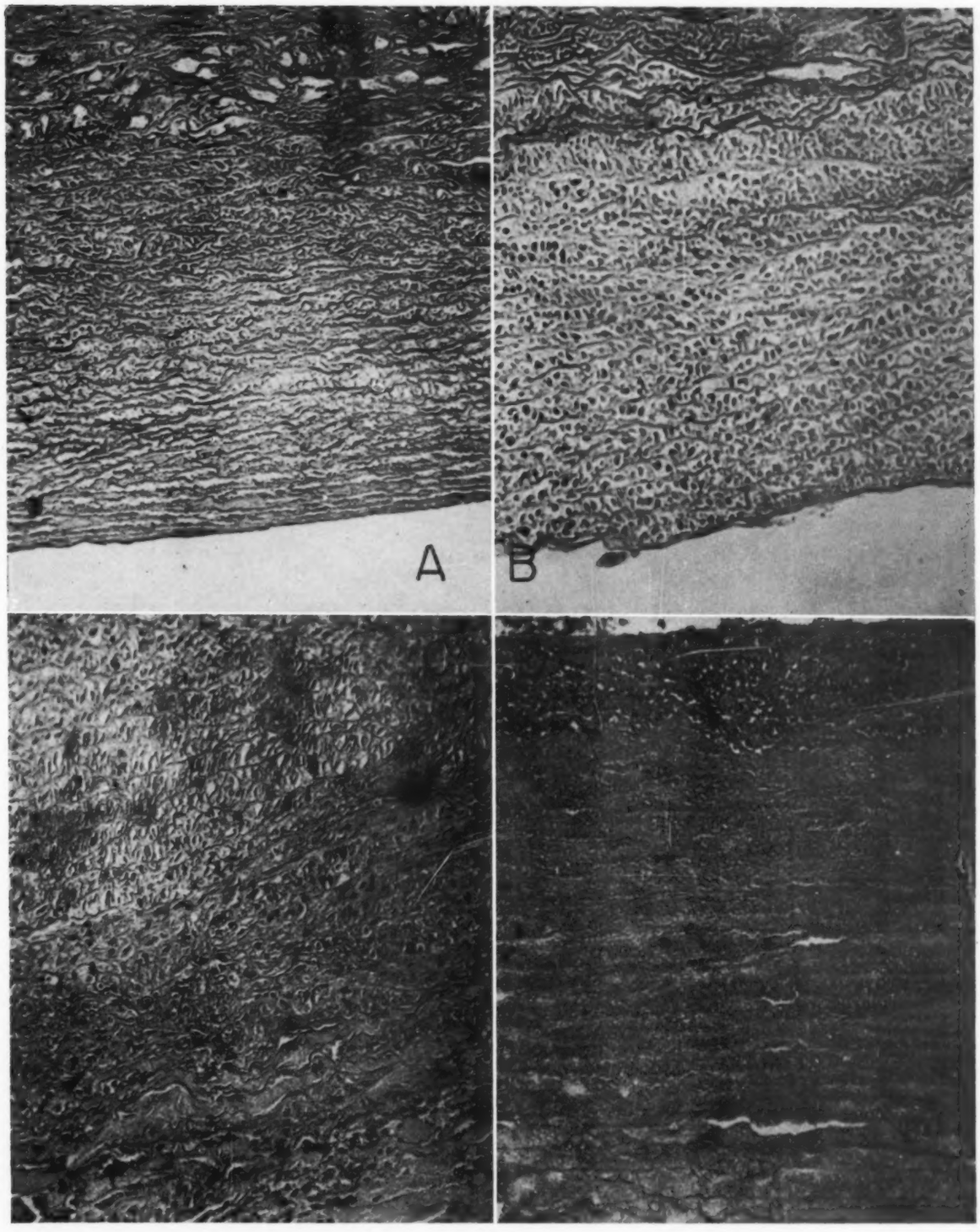

FIG. 4. Degeneration of muscle cells in media of aortic grafts. A, freeze-dried aortic graft stored for one week and implanted for one week showing almost complete disappearance of the cells; B, fresh aortic graft two weeks after implantation demonstrating early diffuse degeneration of the muscle cells; C, fresh aortic graft one week after implantation showing more degeneration toward the intima (above); D, fresh aortic grafts six weeks postoperatively illustrating more degeneration toward the adventitia. Hematoxylin and eosin stain.

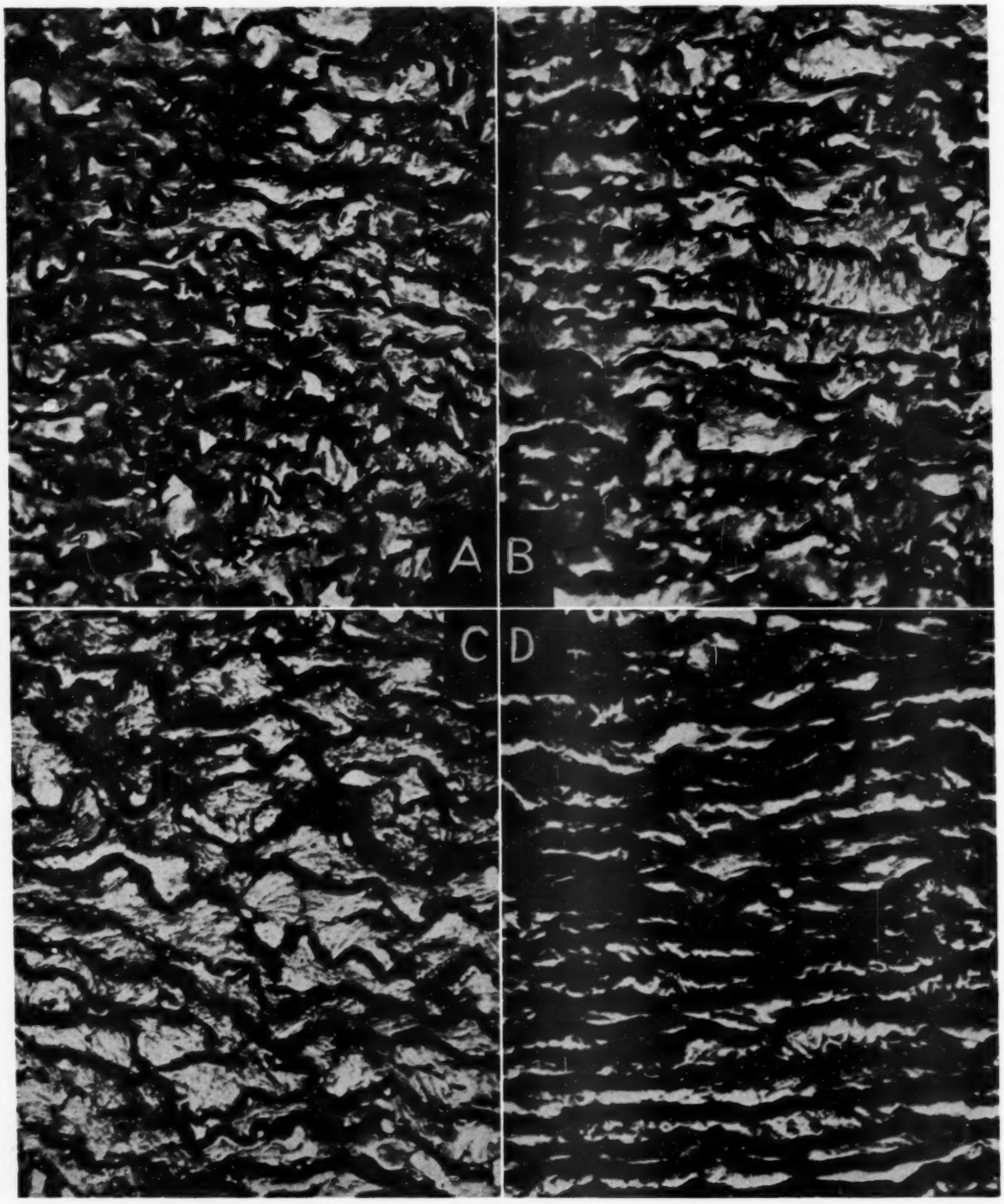

FIG. 5. Elastic fiber changes in freeze-dried aortic grafts (Verhoeff's stain). A, fresh aorta; B, same aorta after freeze-drying; C, specimen from same aorta after freeze-drying and storage at room temperature for one year; D, freeze-dried graft from same aorta stored for three months, three months after implantation.

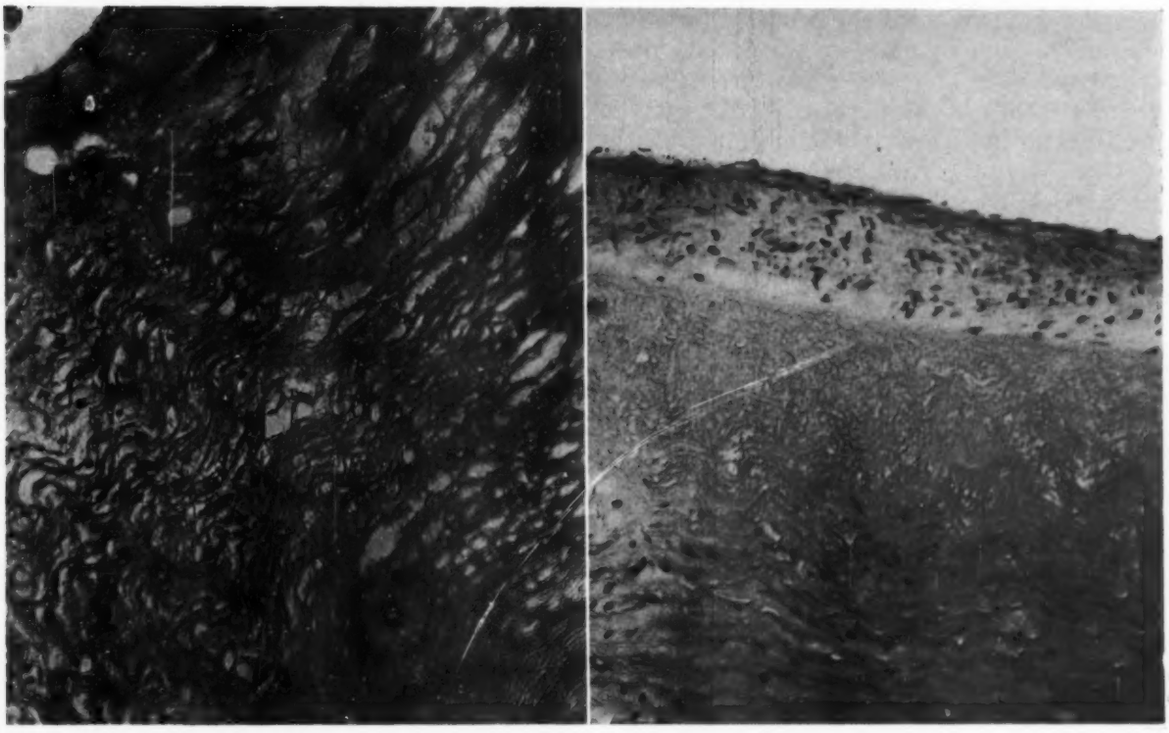

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FIG. 6. Freeze-dried aortic graft six weeks after implantation showing invasion of fibroblasts from the media of the normal aorta (to left), across suture line into the interstices of the media of the graft. Hematoxylin and eosin stain.

FIG. 7. Freeze-dried aortic graft three months after implantation demonstrating intimal replacement and invasion of the media by fibroblasts from the adventitia.

consistently reproducible to within 10 per cent of the median. The thirty-six counts on the fresh aorta and the thirty-six on the graft after varying periods of time following implantation were used to calculate the percentage survival rate of the elastic fibers. Table IV, section IV, shows the results of this study (percentage survival of elastic fibers as a function of the postoperative time). No significant variations between the fresh and freeze-dried grafts were observed. The elastic fibers in aortic grafts are removed at a decelerating rate until about 20 per cent of the fibers have been removed at three months. After three months the remaining fibers seem to persist for periods of at least a year.

Fibrous replacement of aortic grafts occurs from three sites. These are (1) the ingrowing intima, (2) the media of the adjoining normal aorta and (3) the adventitia and surrounding soft tissues. (Figs. 6 and 7.) The replacement from the recipient media seems to be almost insignificant except for suture line healing. The slides were graded for the percentage of the thickness of the media replaced by the fibroblasts from all sources. Again there seems to be faster replacement in the freeze-dried grafts than in the fresh grafts. Table IV, section V, shows the percentage of replacement of the grafts in relation to the postoperative time for each type of graft. It is seen that at six weeks a mean of 40 per cent of the graft wall is invaded by fibroblasts in the freeze-dried group but only 13 per cent in the fresh group.

The amount of reaction in the surrounding tissues such as adhesions and scarring was graded at 0 to 4 plus at the time of autopsy and confirmed by microscopic examination. In both groups the reactions decreased from the first to the twenty-fifth postoperative week. There was distinctly less reaction in the freeze-dried than in the fresh grafts.

The only correlation between the microscopic studies and the clinical behavior of the graft is the possible relationship between the slower suture line healing of the fresh grafts and the rupture seen in a few cases in this

group. The ruptures usually occur at the suture line and most frequently in the second postoperative week. The more rapid healing in the first few weeks in the freeze-dried than in the fresh grafts may account for the absence of rupture in this series. The rate of re-endothelization, while interesting, probably has no clinical significance since thrombosis occurs during the days immediately following operation, at which time both types of grafts lack endothelium. In like manner, the faster replacement of the freeze-dried grafts may appear favorable. However, no ill effects of the slower replacement of the fresh grafts have been observed.

CONCLUSIONS

From these relatively short-term studies it is indicated that properly freeze-dried aortic grafts are superior to grafts preserved by the other methods of storage used to date. Such satisfactory comparisons with fresh grafts have not been reported for any other method of storage.

Certain advantages appear to have practical significance under these experimental conditions. (1) Technical errors of processing can be minimized, measured and accurately controlled. (2) Only minimal care need be exercised during storage. The grafts are stored in ampuls at any climatic temperature and humidity with no care except to prevent breakage of the glass. (3) Prolonged storage time allows stock-piling, greatly reducing waste. (4) Grafts can be quickly and easily prepared for implantation. (5) Clinical results are excellent in the experimental animal. More animal experimentation and carefully controlled human clinical trial is indicated.

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AN ANALYSIS OF ANESTHETIC SAFEGUARDS*

REPORT OF A NATIONAL SURVEY

HERMAN W. SCHWEIZER, M.D. AND PAUL M. WOOD, M.D.

East Orange, New Jersey *New York, New York*

NOTHING makes better headline news than the report of an anesthetic explosion. Nothing is quite as sensational and as dramatic to the lay public, or as startling and terrifying to medical personnel. Haas, Hibshman and Romberger[1] remarked in 1941 that "despite unremitting effort, explosions are still taking place, deaths have occurred, and there has been much ado in the lay and medical press."

A nationwide survey was started in 1948 by the Section of Anesthesia, Halloran Veterans Administration Hospital, because of the continuing incidence of this hazard. A detailed analysis of the safety factors, or the lack of them, currently employed in hospitals throughout the country was made. This review supplements the Greene report on fire and explosion hazards (1846–1937).[2]

PHYSICAL AND CHEMICAL FACTORS

A review of some of the known physical and chemical data in the incidence of anesthetic fires and explosions, to promote a better understanding of the causes and to educate the anesthetist in the factors which may decrease the incidence of these explosions, is pertinent.

Minimum Ignition Temperatures. Table I shows that high concentrations of oxygen lower the minimum ignition temperatures of a combustible agent as compared with air. Nitrous oxide lowers the ignition temperature more than oxygen.[3]

Densities of Anesthetic Gases and Vapors. The rate at which a gas or vapor will diffuse or mix with air is inversely proportional to the square root of its density (Graham's law). Hence richer mixtures of ethylene will pass through the explosion range and become nonexplosive more readily than a heavy vapor such as ether.[3] (Table II.)

Limits of Flammability of Agents. Table III shows the flammability ranges of agents in air, oxygen, and nitrous oxide (U. S. Bureau of Mines).

Electrostatics. Horton[4] has indicated that a spark between two bodies can occur only when there is no electrical path of good conductivity between them. Every spark is a manifestation of the natural tendency of an electrostatic charge to bring adjoining surfaces to an equal potential.

TABLE I
MINIMUM IGNITION TEMPERATURES, DEGREES CENTIGRADE

Agent	In Air	In Oxygen
Ether	304	182
Divinyl ether	399	327
Ethylene	490	485
Cyclopropane	498	
Ethyl chloride	517	468

The static spark is sudden and unpredictable; yet the spark may be *partly* controlled by a thorough understanding of the basic factors which lead to its generation. These factors will be discussed later in the survey analysis.

Ignition Sources. The sources for ignition of a flammable or explosive mixture are numerous. They may be classified as follows: (1) flames (pipes, cigarettes, gas, alcohol lamps); (2) electricity (motors, heaters, x-rays, cauteries, poor switches, endoscopes, diathermy, lighting [portable or stationary]); (3) static electricity (friction from motions of people, gases, liquids, parts of equipment, blankets, clothing, bags, tables, adhesive removal, rubberized sheets, many plastics); (4) miscellaneous (spontaneous combustion, oil on oxygen or air valves under pressure, excessive compression).

* Approved at the Veterans Administration Hospital, Brooklyn, N. Y., from research done at the Veterans Administration Hospital, Staten Island, N. Y., prior to its deactivation. The statements and conclusions published by the authors are a result of their own study and do not necessarily reflect the opinion or policy of the Veterans Administration.

It is unfortunate that all of the commonly employed inhalation anesthetic agents, with the exception of nitrous oxide and chloroform, are used at times in flammable and/or explosive concentrations. It has been shown that "mixtures of an explosive gas, 20% or more oxygen,

TABLE II
DENSITIES OF ANESTHETIC GASES AND VAPORS

Air	1
Ethylene	0.97
Cyclopropane	1.45
Ethyl chloride	2.23
Divinyl ether	2.42
Ether	2.56

TABLE III
LIMITS OF FLAMMABILITY OF AGENTS

Agent	In Air (%)	In Oxygen (%)	In Nitrous Oxide (%)
Ethylene	3.05–28.6	2.9 –79.9	1.9–40.7
Cyclopropane	2.4 –10.3	2.48–60.0	1.6–30.3
Diethyl ether	1.85–36.5	2.1 –82.0	1.5–24.2
Divinyl ether	1.7 –27.0	1.85–85.5	1.4–24.8
Ethyl chloride	4.0 –14.8	4.05–67.2	2.1–32.8

with the addition of a third gas, or even a fourth gas such as helium or nitrogen, may produce a broader non-explosive but anesthetic zone than is possible with oxygen plus but a single anesthetic gas."[5] Thus gas mixtures containing oxygen and an explosive gas in proportions to produce anesthesia may have the safety factor increased by the addition of other gases.

THE SURVEY

A total of 6,400 questionnaires were circulated to registered hospitals throughout continental United States and its possessions, including Alaska, Canal Zone, Guam, Hawaii, Puerto Rico and the Virgin Islands. Of these 6,276 were sent to hospitals in continental United States and 124 to hospitals in United States possessions. The total replies received were 2,285, or 35.7 per cent of the total circulated. (Table IV.) Of the over-all total replies 333 hospitals (14.5 per cent) reported that they had no facilities for anesthesia or surgery. (Table V.) Hence the analyzable total is 1,952 replies, or 30.5 per cent of the total circulated. Sixty-nine (3.5 per cent) fires and explosions were reported for an eleven-year period (1938–1948).

TABLE IV
GEOGRAPHIC DISTRIBUTION
(Total Replies Received)

Marginal No.	State and Territories	No. of Replies Received
1	Alabama	27
2	Arizona	26
3	Arkansas	20
4	California	181
5	Colorado	40
6	Connecticut	52
7	Delaware	8
8	Florida	54
9	Georgia	37
10	Idaho	*
11	Illinois	*
12	Indiana	*
13	Iowa	*
14	Kansas	*
15	Kentucky	3
16	Louisiana	30
17	Maine	30
18	Maryland	43
19	Massachusetts	126
20	Michigan	112
21	Minnesota	93
22	Mississippi	34
23	Missouri	54
24	Montana	22
25	Nebraska	42
26	Nevada	4
27	New Hampshire	15
28	New Jersey	73
29	New Mexico	20
30	New York	225
31	North Carolina	36
32	North Dakota	20
33	Ohio	113
34	Oklahoma	43
35	Oregon	37
36	Pennsylvania	166
37	Rhode Island	12
38	South Carolina	26
39	South Dakota	24
40	Tennessee	47
41	Texas	133
42	Utah	11
43	Vermont	13
44	Virginia	14
45	Washington	57
46	West Virginia	29
47	Wisconsin	73
48	Wyoming	8
49	Alaska	8
50	Canal Zone	1
51	District of Columbia	12
52	Guam	1
53	Hawaii	18
54	Puerto Rico	12
Total replies		2,285

* Replies from these states not tabulated

In all, hospitals in the forty-eight states, the District of Columbia and five possessions returned replies. Of the 333 hospitals which reported no facilities for anesthesia or surgery, reports were returned from hospitals in thirty-seven states, the District of Columbia and two possessions. Fires and explosions in this survey were reported in hospitals in nineteen states and the District of Columbia. (Table VI.)

Table VII enumerates the replies received for each item in the questionnaire in a preliminary analysis of hospitals in the states of California, New York and Texas. These three states were selected for this analysis as being fairly representative for a survey of states in the East, Midwest and South, and the West.

TABLE V
GEOGRAPHIC DISTRIBUTION
(No Facilities for Anesthesia or Surgery)

Marginal No.	States and Territories	No. of Replies Received
1	Alabama	5
2	Arizona	2
3	Arkansas	1
4	California	30
5	Colorado	5
6	Connecticut	15
7	Delaware	2
8	Florida	9
9	Georgia	5
15	Kentucky	1
16	Louisiana	2
17	Maine	4
18	Maryland	12
19	Massachusetts	11
20	Michigan	19
21	Minnesota	11
22	Mississippi	2
23	Missouri	6
25	Nebraska	1
27	New Hampshire	1
28	New Jersey	17
29	New Mexico	5
30	New York	41
31	North Carolina	4
33	Ohio	22
34	Oklahoma	6
35	Oregon	4
36	Pennsylvania	29
38	South Carolina	3
40	Tennessee	9
41	Texas	12
42	Utah	2
43	Vermont	1
44	Virginia	2
45	Washington	2
46	West Virginia	3
47	Wisconsin	22
49	Alaska	1
51	District of Columbia	2
53	Hawaii	2
Total		333

TABLE VI
GEOGRAPHIC DISTRIBUTION
(Fires and Explosions)

Marginal No.	State	No. of Fires	No. of Explosions	Total
1	Alabama	1	..	1
4	California	2	1	3
5	Colorado	..	2	2
6	Connecticut	1	2	3
11	Illinois	..	1	1
17	Maine	1	1	2
18	Maryland	..	1	1
19	Massachusetts	1	4	5
20	Michigan	..	2	2
21	Minnesota	..	1	1
23	Missouri	1	..	1
25	Nebraska	..	1	1
28	New Jersey	..	2	2
30	New York	9	12	21
33	Ohio	..	1	1
34	Oklahoma	1	..	1
36	Pennsylvania	5	5	10
41	Texas	4	2	6
47	Wisconsin	..	2	2
51	District of Columbia	2	1	3
	Totals	28	41	69

This may serve as a cross section of the anesthesia hazard for the nation.

Table VIII indicates completion of the questionnaire by types of personnel.

ANALYSIS OF INDIVIDUAL ITEMS

Conductive Flooring. Many types of flooring have been reported in operating rooms. Among these the following were listed: terrazzo floor with brass strips; terrazzo floor without strips; terrazzo type with 6½ inch square copper grid; leaded floor; steel netting; wire mesh, type not noted; tile, type not listed; ceramic tile; tile, "conductive when moist"; vitreous tile; concrete floor; cement floor; wood floor; conductive linoleum; rubber, type not stated; hubbelite; "partial" conductive flooring and "calcium chloride wash on ordinary flooring."

How do these replies compare with what is

considered good practice? In his analysis of the problem of preventing anesthetic explosions Horton[4] has offered the following recommendations:

1. Incorporation of metal strips in a flooring of terrazzo or tile. However, measurements made on such floors have shown that the resistance of any intercoupling path thus provided is excessively high and exceedingly variable. Fatal explosions of electrostatic origin have been reported in operating rooms equipped with this type of flooring.

2. Flooring of conductive rubber with highly conductive wire screen embedded in the finished sheet.

3. Embedding copper screening in the upper surface of a layer of cement on which thin porous tiles have been laid. The conductivity depends on the moisture which is absorbed and varies with the relative humidity and temperature. It is less effective than the aforementioned (No. 2).

4. Improved conductivity of tile and terrazzo flooring by treatment with calcium chloride (2 to 4 per cent) which should either be kept moist or allowed to dry without mopping. This will impart sufficient conductivity to the surface to provide a free path for the dissipation of static.[6] However, even with these treatments the resistance of this flooring remains dangerously high and variable.

5. Drag chains on equipment to tile floors must be bronze rather than iron or steel.

It should be pointed out that many operating rooms equipped with fine conductive flooring inadvertently nullify good conduction by the use of ordinary floor wax for the purpose of maintaining a high glossy polish. This wax serves as an excellent insulating layer against good grounding between the standee and the floor, and may act in the manner of a condenser.

Talcum powder is another insulating agent on well grounded conductive flooring which can readily nullify good conduction. This fact is worth remembering if conductivity is to be maintained.[5] The wearing of cloth, stockinette or canvas booties by personnel in operating rooms often acts as an insulator and should, therefore, be discouraged.

TABLE VII
QUESTIONNAIRE ANALYSIS

Item	California			New York			Texas		
	Yes	No	No Reply	Yes	No	No Reply	Yes	No	No Reply
Conductive flooring	42	87	52	58	103	64	25	65	43
Grounding of all equipment	64	61	56	78	82	65	47	49	37
Intercoupling	59	59	63	67	76	82	27	51	55
Non-sparking electrical equipment	40	23	118	56	20	139	32	16	85
switches	82	40	59	127	30	68	61	27	45
sockets	74	46	61	110	44	71	47	37	49
spark proof motors	74	36	71	111	36	78	56	29	38
safety lamps	70	43	68	106	43	76	56	31	36
other	8	40	133	15	32	178	6	28	99
Air-humidifying apparatus	24	98	59	41	112	72	20	66	47
Air-conditioning	50	68	63	35	120	70	47	42	44
Clothing:									
conductive shoes	32	91	58	51	102	72	20	66	47
prohibition of silk, woolen, synthetic textiles	68	51	62	103	46	76	54	35	44
Prohibition of the following during flammable anesthetics									
cautery	97	27	57	111	44	70	79	17	37
diathermy	103	14	64	112	27	86	75	14	44
open flame	113	8	60	138	10	77	81	9	43
x-ray	84	33	64	99	50	76	69	18	46
endoscopies	72	34	75	94	42	89	56	22	55
Periodic instruction of operating room personnel	80	39	62	118	29	78	66	20	47

Grounding of All Equipment. The replies included such methods of grounding as: "partial" grounding of equipment; wet towels around equipment; wet towel ground on dry days only; drag chains on tables and machines; grounding wires embedded in floor; and conductive rubber face masks, bags, casters on machines.

TABLE VIII
COMPLETION OF QUESTIONNAIRE

Completed by	California	New York	Texas
Anesthesiologist	24	63	10
Nurse anesthetist	10	9	21
Medical superintendent	25	24	24
Lay superintendent	49	51	42
Physician (specialty not specified)	14	9	9
Other (not specified)	59	69	27
Totals	181	225	133

In his comment on grounding one respondent stated unequivocally that "the grounding of equipment can never be made completely successful, and, therefore, it is unwise to ground any of it." It should be obvious that partial grounding of equipment is almost as inadequate as no grounding of equipment as it offers a false sense of security.

Drag chains, conductive rubber wheels and crutch-tip leg pieces on stools and cabinets must be maintained free of waxy film and other insulating material if conduction is to remain effective. It should be remembered that "grounding" implies direct electrical connection to some highly conductive metallic body having good contact with the earth. Hence it implies good electrical contact with any metallic framework of the building such as the heating, ventilating or plumbing system.[4] Drag chains on operating room furniture are the simplest solution for grounding, provided these chains are free from oil or other insulating material. Bronze chains do not spark on striking contact with tile, marble or other flint-like substance. Grounding conductors may be of any nonspark-producing material. To be effective a drag chain with a known resistance, or other grounding material, must cover at least 2 to 4 inches of floor. The grounding material must not be so long as to catch under rollers or casters.

Intercoupling. The answers included the following: intercoupling "only when cyclopropane was used"; Horton intercoupler; graphite cords in place of intercoupling; "some of our anesthetists think intercouplers are useless"; "nuts!"; and intercoupling by frequent personal contact with the machine, table and patient ("bridging").

Horton[4] in his recommendation of high resistance intercoupling suggests this measure as one technic in the elimination of the spark hazard. He states that a remedy is the interposition of a small electrical unit having a number of terminals. Between any two of these terminals is a conductive path having a resistance of one megohm (one million ohms). The intercoupled bodies are the patient, anesthetist, gas machine and operating table. The resistance is low enough to equalize potentials and high enough to prevent shock if the intercoupler accidentally makes contact between a person and the lighting or power circuit.

While some respondents believe that intercouplers are useless, the principle of intercoupling remains sound and its practice is recommended, particularly in operating rooms of low humidity. This increases the safety factor but does not guarantee complete safety.

Non-sparking Electrical Equipment. The following were reported: Crouse-Hinds switches; mercury switches in sockets; all switches and sockets above 48 inches wall height; lamps kept 7 feet off the floor; "mercoid" switches; "keyless" sockets with no paper lining.

One anesthetist states, "The value of spark-proof sockets is negated by the use of ordinary male-female extension cord junctions between spark-proof sockets and apparatus." Another states, "We go along with the non-sparking electrical equipment since it (non-adherence) is the most likely to get you in trouble from the medical-legal point of view. However, we make no particular effort to worry about it."

All electrical junctions must be so constructed as to be entirely spark-proof. Austin[7] placed the blame for the failure of wider usage of explosion-proof receptacles on the lack of resourcefulness of manufacturers to design explosion-proof switches and receptacles which could be readily installed in existing

wall outlets. However, in 1940 explosion-proof features which could be installed in already existing wall outlets were developed for switches and wall receptacles. The design imprisons the arc in an explosion-resisting chamber, thereby rendering it harmless to surrounding atmosphere containing combustible and flammable mixtures.

Greene[8] has collected fifty-eight cases of combustion in suction and vaporizing machines and lists five possible sources of electrical sparks: (1) Arcs produced at the make or break of the electrical circuit by the ordinary open switch. (2) Sparks produced by the revolving armature of the motor. (3) Sparks produced by the electric current which may be induced in the metal shell of the cabinet by the operation of the motor. (4) Sparks produced by static electricity caused by friction of parts of the apparatus within itself or against external objects. (5) Arcs produced by the make and break of contact of the plug with the wall socket.

Safe procedure dictates removal of the flexible delivery tube from the machine when not in use so that it may not be inadvertently discharged into an ignition source.

Air-humidifying Apparatus. Reported were the following: Powers regulator, humidiguide in all rooms and daily check of humidity.

Horton,[4,5] Greene[2] and others have recommended a high relative humidity in operating rooms of at least 55 per cent (65 per cent according to others) since moisture films on the surface of insulators (rubber, glassware) inhibit the retention or development of charge. However, air-conditioning equipment which provides high humidity may also remove carbon dioxide from the air and destroy the humidity as a path for the flow of electrical energy. This on a theoretic basis lessens the ionization of air and increases the static hazard.

The humidiguide is a practical device in operating rooms and its inclusion is highly recommended.

Air-conditioning. The replies reveal little of interest concerning this item. One respondent recommends an apparatus which provides twelve to fifteen air changes per hour through a washed-air diffuser.

Under this heading may be included the problem of ventilation in the operating room. The purpose of this factor is to provide for the movement of air to the extent of diffusing concentrations of explosive agents which have formed in pools and pockets (cyclopropane, ethyl chloride, divinyl ether, ether).[6] Ether vapor characteristically forms pockets since it is heavier than air and is dispersed very slowly. It may flow along the floor as water would flow leaving a stream of ether vapor which may reach a wall in the vicinity of an exposed electrical outlet. Cyclopropane is less likely to form pockets and pools. It is heavier than air, is a more active gas and is readily dispersed.[5]

Greene[3] recommends ventilation as essential in the use of the cautery, the direction being from the cautery toward the patient's head.

Clothing. Reported were the following: (1) cotton or canvas boots; (2) leather soles, rubber heels; (3) cotton blankets; (4) "not necessary if three feet from the gas bag, and if anesthetists do not relieve each other. Everyone is kept away from the gas machine. No break in circuit"; (5) "visitors are not allowed, unless in cotton apparel"; (6) "the anesthetist is the biggest offender"; (7) ". . . when surgeons cooperate"; (8) conductive shoes, "copper nails"; (9) "hard to enforce"; (10) "doctors are the worst offenders."

Horton[4] indicts non-conductive crepe-soled shoes as the worst offenders as effective generators of static electricity. Rubber- and most composition-soled shoes act as effective insulating barriers against equalization of potential. A small drag chain on each shoe annuls the electrostatic action of rubber. Current opinion on leather soles,* according to Horton, is indecisive. The soles of shoes are affected by weather conditions which cause drying of leather during hot summer months with a consequent increase in resistance. Thus in the summer there may be increased resistance of leather-soled shoes to as high as 10 megohms; in the winter resistance may be as low as 0.01 megohm. A resistance of 1 megohm is generally found between the standee wearing leather-soled shoes and the conductive rubber floor with grounded mesh. Accumulated charges, even as high as 100 megohms, are dissipated through conductive floors in a fraction of a second;

* Since preparation of this report Dr. Greene has again pointed out that for all practical purposes leather-soled shoes are adequate in anesthetizing locations.[13]

normally lesser charges are dissipated in considerable smaller fractions of time.

Non-conductive pads and pillows are a serious hazard. In moving a patient from the stretcher to the operating table, he may acquire and retain an electrostatic charge of dangerous magnitude. This hazard may be reduced by providing an intercoupling link (bracelet) permanently attached to the operating table. Removing a fabric case from a non-conductive rubber pillow in the operating room should be prohibited when flammable gases are in use; by the same token non-conductive sponge rubber cushions on anesthetists' stools should be prohibited. Woolen, silk, nylon, rayon, sharkskin and non-conductive plastic outer garments should never be allowed in the operating room. Undergarments of silk, nylon or wool involve a negligible hazard compared to those in outer garments. It is thought unnecessary to impose any restrictions on choice of materials used for undergarments by operating room personnel.

Non-conductors, such as rubber gloves, silk hose and the like, which are in intimate contact with the skin of the wearer do not usually accumulate sufficient static to become hazardous. The same is not true, however, of outer loose-fitting clothing or drapes.[6]

It is of interest to note, in a review of static voltages, that a man wearing leather-soled shoes taking four steps on a dry tile floor may generate 500 volts, an anesthetist rising from or being seated upon a rubber-cushioned stool, 5,000 volts,[6] a fountain pen, 100 volts and sliding a foot along a rubber floor may generate 200 volts.[5]

It cannot be stressed sufficiently that the hazard of sparking cannot be eliminated without the thorough understanding and complete cooperation of all operating room personnel and operating room visitors. Lack of cooperation may be fatal to the patient, anesthetist, surgeons or visitor, and should indict the offender for his ignorance and/or indifference.

The staticator[9] is an electronic device for the detection and the indication on a meter, and by an amplifying sound system, of the accumulation of static charge. Used in the operating room in the immediate vicinity of an anesthetic machine, this instrument can be of value in warning the anesthesiologist of impending danger. The statometer[10] is another useful instrument which indicates on a meter the presence and intensity of static charge in voltages ranging from 0 to 1,000 volts. These are newer refinements in modern day anesthesia practice for the better-endowed anesthesia department.

Probibition of tbe Cautery, Diatbermy, Open Flame, X-ray, Endoscopies during Administration of Flammable Anesthetics. In a review of replies it is noted that the use of the cautery, for example, is "frequently compromised"; or that "precautions are allowed for cyclopropane, but not for ether."

Greene[2,3,8,11,12] has made an exhaustive survey of these hazards. He cites his reasons for explosions in general as: (1) ignorance of an elementary knowledge of anesthetic combustion; (2) indifference toward the hazard because of past good fortune while using setups in the operating room which we consider dangerous; (3) paucity and inflexibility of anesthetic methods available to many surgeons who must use the cautery; (4) ignorance or indifference to the principles of the physics of electricity. He considers the remedy to be education and elevation of the standards of anesthesia training and practice.

The use of the cautery should be prohibited near the mask (or anesthesia apparatus) or in operations of the head and neck or pleural cavity when flammable anesthetic gases are used. Cautery in the abdomen is relatively safe only when a screen or curtain is placed between it and the patient's face, and when the screen is so arranged as to provide against pockets for the entrapment of flammable agents.

Greene lists the following recommendations:

1. Inquire before operation as to the probable use of the cautery.

2. If the cautery must be used in critical areas (head, neck, respiratory passages, pleural cavity), the anesthetic must be of the non-combustible type (regional block, nitrous oxide, chloroform, intravenous, rectal basal, combinations).

3. If the cautery must be used in distal areas (abdomen, pelvis), the choice should be a non-combustible anesthetic considering first that the safety, for other reasons, to the patient is not jeopardized by this substitution.

4. If the cautery must be used in regions listed previously (No. 3) and a combustible anesthetic must be used, a meticulously closed-circuit method of administration should be in use during the prior ten minutes. Com-

bustible anesthetic of choice: ether-air closed-circuit administration because of its smaller tendency toward propagation and smaller range of explosibility as compared with ether, ethylene or cyclopropane mixtures with a high concentration of oxygen or nitrous oxide. Cyclopropane, ethylene and ether with oxygen are permissible in special cases. Ventilation is essential, the direction being away from the cautery and toward the patient's head. The patient should be securely in the third plane to be certain no vomiting occurs to break the closed circuit. No part of the cautery, wires, switch, or rheostat should be near the anesthetic apparatus. A draped screen should intervene between the patient's head and the field of operation.

5. If the cautery is to be used in hollow viscera in the abdomen (bladder, stomach), the viscus should be emptied of its gaseous contents first.

With surgical diathermy sparking or arcing may appear in five zones: (1) at the active electrode; (2) within the cabinet of the apparatus if the machine has defective insulation; (3) at foot or hand switch controlling a make and break of the circuit; (4) at the wall plug socket during make and break; (5) at many scattered and unpredictable points where a high frequency current or induced current jumps an air gap formed between the patient and a grounded conductor. Anesthetic fires and explosions ignited by diathermy are completely preventable only by the use of non-combustible anesthetic agents.

Greene[2] reports that the use of electrically lighted instruments in body cavities during anesthesia, especially in the mouth and larynx, caused five anesthetic combustions, the death of one patient and serious injury to another. Such disasters may be prevented by: (1) solid glass rather than thin bulbs; (2) lamp bulb contact so arranged in the socket that no sparking can occur; (3) bulb should not become excessively hot during prolonged use; (4) lamps should be supplied with low-voltage currents in range of 3 to 4½ volts; (5) insulation, rheostats and switches should be free of short-circuiting faults; and (6) lamp circuit, if fed by house current, should be free of hazard of electrical burn and shock.

It should be remembered that, for explosions to occur, the following conditions must co-exist: the presence of a combustible agent; a proper proportion of mixture; the presence of oxygen; and heat of a sufficient degree.

Periodic Instruction of Operating Room Personnel. The most common reply is summarized in the following two typical statements: "unimportant and unnecessary if common sense is generally applied" and "use your head—be careful."

The survey indicates that most hospitals conduct periodic instruction. It is necessary to remind all personnel constantly of the necessity for an awareness of the explosion hazard as long as open flammable agents are used in operating rooms. It is shocking to note the frequency with which posted regulations are disregarded by surgeons, nurses and even occasionally, by anesthetists. This disregard may well be considered an infringement upon the safety rights of the patient and all personnel and is condemned. Personnel should be made aware of the physics of electrostatics, grounding, induction and conduction, intercoupling and the contribution of shoes and clothing to the fire and explosion hazard. The importance of not approaching the anesthesia apparatus must be stressed.

Other Measures. There were very few comments made. However, the following measures are deemed important as further safeguards against fires and explosions: (1) posting and enforcement of regulations relative to anesthetic gases and equipment; (2) maintenance of frequent inspections of the mechanical state of equipment; (3) posting and observance of "no smoking" regulations; (4) posting of regulations concerning the use of cauteries and electrosurgical units during anesthetic procedures; (5) observance of precautions by personnel and visitors in operating rooms during the administration of flammable anesthetics in connection with wearing of proper apparel and avoiding approach to anesthesia apparatus; (6) periodic inspection of electrical equipment (wiring, sockets, cords, lamps, motors and other devices); (7) inculcation of constant vigilance against the explosion hazard; (8) posting of specific danger areas where flammable or explosive mixtures may be present; (9) familiarity with National Fire Protection Association Publication No. 56: "Recommended Safe Practice for Hospital Operating Rooms," 1949.*

* Obtainable from National Fire Protection Association, 60 Batterymarch St., Boston 10, Mass. Price $.25.

SUMMARY AND CONCLUSIONS

This article analyzes the returns of a nationwide survey on anesthetic safeguards currently practiced in operating rooms. It reviews the chemical and physical factors which are responsible for the elaboration of electrostatic charges. It analyzes individual items from a questionnaire relating to the problem of anesthetic safeguards.

The replies reveal confusion, vagueness and an unrealistic attitude concerning a real hazard. While there is an awareness of fire and explosion hazards, there is, on the other hand, a disturbing negligence as to physical measures and adherence to accepted prohibitions by operating room personnel in many hospitals in which dangerous flammable and explosive agents are used.

In view of the fact that this article does not cover an analysis of actual explosions it cannot attempt to summarize the causes of these explosions. This is the subject of a separate analysis.[14]

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CARDIAC ARRHYTHMIAS DURING ANESTHESIA*

A COMPARISON OF CYCLOPROPANE AND PENTOTHAL-NITROUS OXIDE-ETHER ANESTHESIA

JACK L. EISAMAN, M.D., HAROLD D. CAYLOR, M.D., CHARLES E. JACKSON, M.D. AND HELEN ROE, R.N.

Bluffton, Indiana

FOR this study we have routinely made electrocardiograms on patients undergoing major surgery. This report gives data on the incidence of cardiac arrhythmias during cyclopropane and pentothal®-nitrous oxide-ether anesthesia, and their treatment with intravenous procaine.

In the early work with electrocardiograms during surgery[1–3] cardiac arrhythmias were noted to be of frequent occurrence. These studies were made before the general use of cyclopropane. In the recent years, since this anesthetic agent has been popularized and longer major surgical procedures performed, numerous cases of cardiac arrest have been reported. Cessation of normal cardiac rhythm can be readily detected during an open thoracotomy; however, in other types of major surgery this is not so readily ascertained by clinical means. Taylor[4] in 1941 reported an incidence of only 6.5 per cent arrhythmias in 41,690 patients under cyclopropane anesthesia, whereas others with the aid of the electrocardiogram have found a much higher percentage of arrhythmias,[5] especially extrasystoles of ventricular origin. These findings suggested the advisability of making the electrocardiograph standard operating room equipment.

METHODS AND MATERIAL

A Sanborn direct-writing electrocardiograph was used in this study utilizing long patient lead wires. Practically every adult who contemplates major surgery in this clinic and hospital has had a cardiac survey including an electrocardiogram prior to surgery. Three standard limb leads are taken in surgery just prior to or immediately after induction. The anesthetist takes tracings every five or ten minutes and records any irregularity in rhythm detected by observing the continuously moving stylus.

Cyclopropane. Table I lists 114 arrhythmias encountered in 113 procedures in which cyclopropane was used. One hundred five patients were given only cyclopropane in conjunction with the routine preoperative medication of $\frac{1}{6}$ to $\frac{1}{4}$ gr. morphine and $\frac{1}{150}$ gr. atropine. Four patients were given a pentothal induction followed with cyclopropane then shifted to ether.

TABLE I

Type of Rhythm		Frequency
Ventricular rhythms		85
Multiple and multifocal ventricular premature contractions	41	
Pulsus bigeminus	23	
Occasional ventricular premature contractions	15	
Ventricular tachycardia	3	
Cross dysrhythmia	2	
Ventricular fibrillation and cardiac arrest	1	
Auricular rhythms		18
Auricular premature contractions	11	
Wandering pacemaker	5	
Auricular fibrillation	2	
Supraventricular Tachycardia		2
Nodular Rhythms		9
Shift in pacemaker from sinus to A-V node	2	
Nodal premature contractions	6	
Nodal rhythm	1	

Forty-three (38 per cent) of the 113 patients (Table II) had no disturbance in rhythm. One of these had 0.1 per cent procaine dripping intravenously from induction until the end of surgery. Seventy patients (62 per cent) had some type of arrhythmia as listed in Table I. Cases of sinus tachycardia were usually transient and not included. The multiple and multifocal ventricular premature contractions were

* From the Department of Medicine, Surgery and Anesthesia, Caylor-Nickel Clinic and Clinic Hospital, Bluffton, Ind.

the most frequent arrhythmias and are generally considered the most dangerous. The heart may go into a gross dysrhythmia and ventricular fibrillation from this stage as well as from ventricular tachycardia.

Table II gives our results with intravenous procaine in treating these arrhythmias. Twenty-nine patients (25.6 per cent) had procaine intravenously. Only one patient had intravenous procaine by continous drip. Arrhythmia did not develop in this case. Eighteen patients with ventricular arrhythmias had the rhythm restored to normal with intravenous procaine (three patients were greatly improved but not completely restored to normal). One patient required procaine plus a shift to ether to restore normal rhythm and one returned to normal with ether. Fourteen cases of ventricular arrhythmias were restored to normal without therapy. Procaine was not given in nine other cases of ventricular arrhythmias but the rhythm was not restored to normal. Cardiac arrest developed in one case and is described more completely in another part of the paper.

TABLE II

Type of Rhythm	Restored				Not Restored		Normal	
	Ether and Procaine	Shift to Ether	Procaine Drip	Spontaneously	Cardiac Arrest	Procaine Not Given	Nothing Added	Continuous Procaine Drip
Normal rhythm	..	..	..	..	..	..	42	1
Ventricular arrhythmias	1	1	18	14	1	9	..	..
Combined supraventricular and ventricular arrhythmias	..	..	8	9	..	2	..	..
Various auricular and nodal arrhythmias	..	..	..	..	..	7	..	..
Totals	1	1	26	23	1	18	42	1

Intravenous procaine was used only in the more alarming situations. This included twenty (45 per cent of the group) of the ventricular arrhythmia group. One case required a shift to ether and cardiac arrest developed in another case. Thus in this group intravenous procaine might be considered 90 per cent effective.

In the combined supraventricular and ventricular arrhythmias the rhythm was restored to normal in nine cases without therapy other than increased oxygen supply. However, in eight cases it was believed necessary to give intravenous procaine and in these cases all were restored to normal (one patient had an occasional auricular premature contraction and in another the chronic auricular fibrillation was not influenced).

In the other cases of simple auricular arrhythmia and the case of supraventricular tachycardia intravenous procaine was not used. Thus in this series of twenty-nine cases intravenous procaine might be considered to be 93 per cent effective in restoring rhythm.

Table III lists the incidence of arrhythmia in this series according to cardiac status. The age range and average ages are also stated. Our findings are in agreement with Kurtz, Bennett and Shapiro[3] who found the highest incidence of arrhythmias in cases of cardiovascular disease. It is important to note the high incidence of cardiac arrhythmias with normal heart findings.

Carter and Eisaman[6] reported on the powerful depressant action of intravenous procaine on the myocardium and conduction system. This depressant action has been found beneficial in ventricular arrhythmias. However, hearts suffering from inflammatory or degenerative lesions may tolerate only a fraction of usual dosages. Control electrocardiograms should always be made. Also, the speed of injection may influence the toxic effect upon the heart. In a report on the effect of intravenous procaine on pentobarbitalized dogs Uhley and Wilburne[7] have demonstrated marked prolongation of P-R and QRS intervals, change in

shape and size of all the complexes, and in one case of eight, multifocal sites of excitability in the heart. This report and our previous experience with the drug suggested that rather than direct intravenous injection of 100 mg. of procaine it would be better to use a continuous drip. In most cases of major surgery fluid is being injected intravenously for multiple purposes. In this glucose or saline 5 cc. of 20 per cent procaine are instilled when indicated, making a 0.1 or 0.2 per cent solution of procaine depending upon whether it is 1,000 or 500 cc. initial volume. The rate of drip can be adjusted as to the need. At first it may flow in freely; and when the rhythm is improved or controlled, the rate may be established at 80 to 100 drops per minute. This is a safe procedure in practically all patients able to undergo surgery. We believe that the direct intravenous use of procaine along with that of quinidine intravenously may well be very dangerous. They seem to have a synergistic effect in producing prolonged QRS conduction time as well as other direct depressant effects.

TABLE III

Heart Condition	No Arrhythmia	Arrhythmia
Normal.....	30 cases (47%) Age range 23–73 Average age 52	34 cases (53%) Age range 22–75 Average age 50
Abnormal.....	9 cases (26.4%) Age range 56–73 Average age 65	25 cases (73.6%) Age range 43–91 Average age 62
Possible heart disease	4 cases (26.7%) Age range 46–77 Average age 61	11 cases (73.3%) Age range 37–76 Average age 55

Ether. Table IV summarizes the incidence of arrhythmias in 221 patients under pentothal-induced, nitrous oxide–ether anesthesia. Twenty-one patients showed some type of arrhythmia. Eight patients had one or more types of ventricular rhythms. Three patients had nodal rhythms; eleven had one or more auricular arrhythmias. In this group there was also one case of cardiac arrest (Case II).

Intravenous procaine was used in only five instances in this group (2.2 per cent). In the three cases in which it was used for multiple and multifocal ventricular premature contractions it was successful in restoring rhythm to normal. In the case of cardiac arrest it did not restore the rhythms to normal. The rhythms varied between multiple and multifocal ventricular premature contractions, periods of ventricular rhythms and tachycardia, and arrest periods lasting as long as nine seconds before complete asystole occurred.

TABLE IV

Ventricular rhythms (8 cases):.....	14
Multiple and multifocal ventricular premature contractions.....	4
Occasional ventricular premature contractions	6
Paroxysmal right bundle branch block.....	1
Ventricular tachycardia.....	1
Cardiac arrest.....	1
Pulsus bigeminus.....	1
Auricular rhythms:.....	19
Wandering pacemaker.....	12
Prolonged P-R interval.....	4
Auricular premature contraction.....	2
Auricular fibrillation.....	1
Nodal rhythm.....	3

Cardiac Arrest. Factors in cardiac arrest are numerous. Important ones are hypoxia (any cause) or hyperpnea, hypotension or shock, manipulation or displacement of the heart, preoperative nutrition, electrolyte and psychic balance, underlying cardiac abnormalities and drugs such as digitalis, procaine or quinidine. Perhaps the most important factors are the anesthetic agent and operative field reflexes mediated by way of the vagus.

The first death attributed to anesthesia occurred on January 28, 1848.[8] Beck[9] in an early article on this subject gives a brief history of the early work leading up to our present knowledge and ability to cope with this situation. From this article and a later one[10] by the same author an excellent list of references is incorporated for the benefit of those wishing to review this material. One of the most complete bibliographies on the subject is by Wiggin.[11]

During the five-year period prior to 1950 we had two cases of cardiac arrest. This aroused our interest in early detection of cardiac arrhythmias during surgery by use of the direct-writing electrocardiograph. Since early in 1950 we have routinely taken electrocardiograms in all major surgical cases. The two cases of cardiac arrest which occurred during this study are reported.

CASE REPORTS

CASE I. A sixty-one year old man had noticed a frequent urge to defecate and bloody

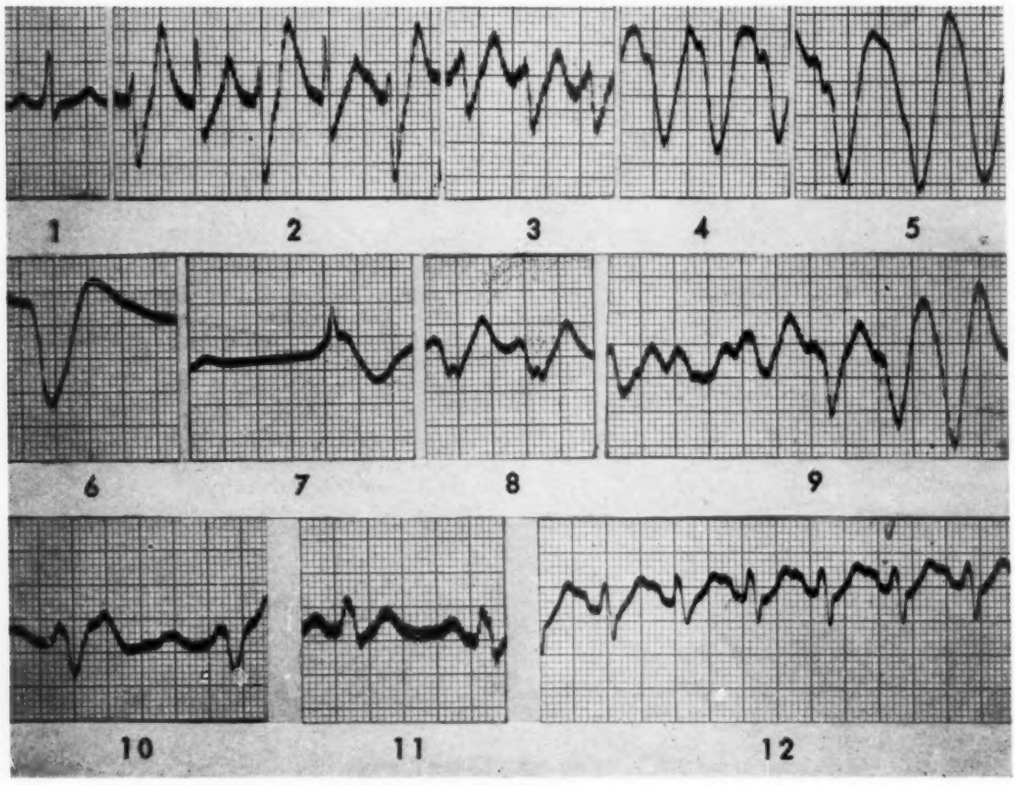

FIG. 1. Case of cardiac arrest.

stools. This proved to be due to adenocarcinoma of the rectosigmoid area. A chest film revealed normal heart and pulmonary findings. Heart and lung sounds and blood pressure were normal. The patient had moderately severe hypochromic anemia. His electrocardiogram was within normal limits; however, an occasional premature ventricular contraction was noted.

On October 8, 1951, an abdominoperineal resection using cyclopropane anesthesia was attempted. The growth was just behind the prostate in the hollow of the sacrum. After the bowel was severed, one portion of a De Martel clamp and a large abdominal pack were placed in the hollow of the sacrum and the peritoneum closed with the colostomy in place. Just prior to closing the patient started to have multiple and multifocal ventricular premature contractions. Forty milligrams of procaine chloride were given intravenously. (Fig. 1, No. 2.) A short time later (No. 3) 60 mg. more of procaine were given intravenously while the heart was in ventricular tachycardia. At this point the bag was emptied of the anesthetic mixture and only oxygen given by mask. Ten minutes later (No. 4) the situation had not improved so 0.8 gm. of quinidine gluconate was given intravenously. Twenty minutes later 0.8 gm. more of quinidine gluconate was given and the condition was not remarkably different. Twenty minutes after the second dose of quinidine (No. 5) there were only fibrillary waves which soon resulted in cardiac arrest. The diaphragm was cut from its anterior attachments and cardiac massage was begun. Intracardiac epinephrine (1 cc. of 1:1,000 solution) was given into the right auricle and another 1 cc. intravenously. Another blood transfusion was started. During this time the patient was given 100 per cent oxygen by bag artificial respiration until heart and respiratory rhythm were re-established. Figure 1, No. 7, shows first a massage contraction with the second complex initiated by the heart. Figure 1, No. 8, represents the patient's own rhythm forty-five minutes after arrest. Fifty minutes after arrest (No. 9) fibrillary waves appeared and procaine drip (No. 10) was started. His rhythm was soon re-established. The diaphragm and abdomen were closed by this time and the patient was returned to his room with the perineal part of

the operation uncompleted. His blood pressure was 60/40. Figure 1, No. 11, represents his electrocardiogram at end of surgery. That evening he recognized his daughter. The next day his chest film was essentially the same as the preoperative film except for the presence of subcutaneous emphysema. On the second postoperative day some atelectasis developed, then later pleural fluid and pneumonic consolidation.

During the next few days he had much cerebral and pulmonary edema. It was believed toxic effects were developing from the retained intra-abdominal pack and avascular gut. Four days later (October 12th) under caudal and sacral block anesthesia and oxygen by gas machine the perineal portion of the operation was completed. Figure 1, No. 12, is lead II during the second operation. On October 16th the patient's abdominal wound dehisced. This was repaired surgically under local anesthesia without much more additional shock. However, his general condition was deteriorating; his nutrition was poor; his white blood count and blood urea nitrogen were rising and he died twelve days after cardiac arrest.

Significant findings at postmortem examination were purulent bronchitis and bronchopneumonia, postoperative atelectasis, pulmonary hyperemia, heart failure cells, emphysema and tracheitis and coronary atherosclerosis. The myocardium for the most part appeared fairly normal. The adrenal gland revealed some cortical cellular degenerative changes.

Case II. A sixty-four year old man had bronchogenic carcinoma of his right lung, which was discovered by a screening film taken for tuberculosis. A thoracotomy and pneumonectomy was performed with the patient lying in the posterolateral position. Endotracheal anesthesia with nitrous oxide–ether was given following pentothal induction.

The three leads taken at the beginning of surgery revealed inverted T waves in leads II and III and one auricular premature contraction. During the course of the operation ventricular premature contractions occurred associated with runs of ventricular rhythm and tachycardia with various foci of excitability. Intravenous procaine drip was started. There were periods of arrest lasting as long as nine seconds before complete asystole occurred.

The pericardium was opened and the heart was massaged as soon as the brief periods of arrest were noted. Immediately the anesthetic mixture was replaced by oxygen and bag-breathing artificial respiration employed. One cubic centimeter of epinephrine (1:1000 solution) was injected into the right auricle on two occasions. Only an occasional contraction occurred after asystole. Cardiac massage and artificial respiration were continued for an hour without a favorable result. The actual reason for failure to revive the patient was not ascertained.

At postmorten examination bronchogenic carcinoma, grade IV, was again found in the lung and also in hilar lymph nodes and adrenal glands. Atherosclerosis with narrowing of coronary vessels and scattered areas of myocardial fibrosis were found.

There is ample information for the treatment of cardiac arrest in the literature. We believe that every surgeon should be prepared for this emergency and have a well trained team and plan of action. We also believe that the electrocardiograph used in surgery is important not only in demonstrating arrhythmias which if untreated might result in cardiac arrest, but also in detecting cardiac arrest so that massage can be initiated early.

SUMMARY

Statistical data is given on the incidence of arrhythmias induced during 334 major surgical cases.

Under cyclopropane anesthesia 62 per cent (70 out of 113 patients) had some type of arrhythmia. Six types of ventricular arrhythmias occurred eighty-five times in sixty-three cases. The multiple and multifocal ventricular premature contractions were the most frequent and dangerous arrhythmias; in this group of cases intravenous procaine for various ventricular or combined supraventricular and ventricular arrhythmias apparently benefited 93 per cent of the patients.

Under pentothal-induced nitrous oxide–ether anesthesia 9 per cent (21 patients of 221) had some type of arrhythmia. Contrast this with 62 per cent arrhythmias in the cyclopropane group. Only eight patients had ventricular arrhythmias. The auricular arrhythmias were more common in this group but not worrisome. Intravenous procaine was effective in the ventricular arrhythmias in this group except in the case of cardiac arrest. A case of cardiac arrest occurred in each group and these are included as case reports.

We believe that this study demonstrates a significant difference between the anesthetics in regard to their potentialities for causing serious disturbances of cardiac rhythm. This study also emphasizes the advantage of using the electrocardiograph in surgery[12] to evaluate better the effect of anesthetic agents on the cardiac mechanism.

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AN EMERGENCY INFRACOSTAL APPROACH FOR CARDIAC ARREST*

DAVID J. WEXLER, M.D., FRED BROMBERG, M.D. AND ANTHONY KOHN, M.D.
Islip Terrace, New York

THE appallingly high mortality in cases of cardiac arrest is undoubtedly due to delay—delay on the part of the anesthetist in making the diagnosis and on the part of the surgeon in acting after the condition has been called to his attention. Cardiac arrest is one of the few conditions where minutes, even seconds, may mean the difference between a living and a dead patient. The lag in diagnosis has been under constant study by anesthesiologists. The routine use of some such instrument as the operating room cardioscope, which gives a continuous visual or audible record of the heart action, would be a distinct advance in this field. Any measure which will facilitate definitive treatment, i.e., direct massage of the heart with the hand, should be brought to the attention of the entire medical profession since a thoracic surgeon or even a general surgeon may not be immediately available under these circumstances. That the condition covers the entire spectrum of surgical practice is evident when we review the cases which occurred at the Southside Hospital in the last four years. Cardiac arrest occurred during the course of a gastrectomy, hysterectomy, prostatectomy, sympathectomy, the wiring of a fractured jaw and bronchoscopy, cases which involved general and traumatic surgeons, urologists, gynecologists, otolaryngologists and dentists. It is probable that in the latter cases the delay in securing a surgeon may have affected the outcome. Therefore, every doctor in the operating room, including the anesthetist, should have in his mind a definite plan of action for dealing with this always sudden and often disastrous emergency. Consideration of such elementary surgical principles as sterility, hemostasis and anesthesia must be abandoned; the only consideration is to restore the beating of the stopped heart before the lapse of the three or four minutes needed to produce irremediable cortical damage.

When cardiac arrest occurs during the course of an open chest operation, massage of the heart presents no great problem. Doubtless the best approach to manual massage of a still heart is through the open thorax. With wide rib retraction, the heart can be adequately visualized and effectively massaged; this and the fact that the heart has been under direct vision contribute to the generally good results reported by thoracic surgeons in the treatment of cardiac arrest.

It is in surgery elsewhere in the body that the problem of the quickest and most adequate emergency approach to the heart arises. Apart from the thoracic approach, the best known methods advocate opening the peritoneum through a median epigastric incision and massaging the heart through the intact diaphragm, and when necessary, opening the diaphragm for more adequate exposure. To one unaccustomed to abdominal surgery, opening the peritoneum may seem a formidable procedure; even to an abdominal surgeon incision and suturing of the diaphragm may be technically difficult. The infracostal approach to be described eliminates the need for rib-spreaders or rib resection as in the thoracic approach and the need in the trans-abdominal approach for opening the peritoneum or diaphragm.

ANATOMY

Anatomically, the infracostal approach is based on a simple fact little stressed in most textbooks. The origin of the muscular fibers of the diaphragm anteriorly is not a continuous ring as is very commonly assumed. The diaphragm arises anteriorly from the posterior surface of the xiphoid process by two slender fleshy slips directed backward (pars sternalis) and laterally from the deep surface of the lower six costal cartilages (pars costalis). Dissecting from below upward, the diaphragm between these two muscular origins can be readily and

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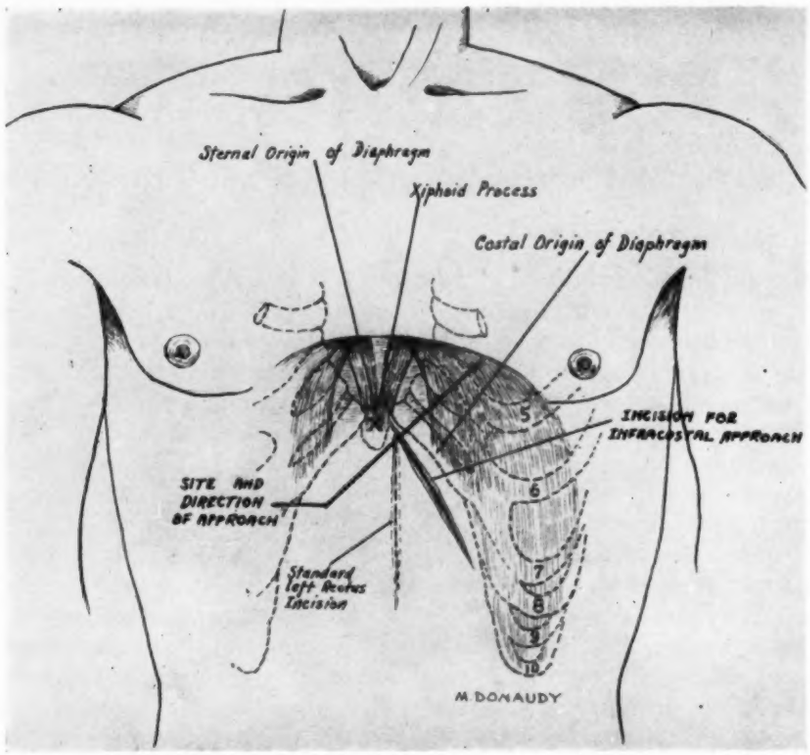

FIG. 1. Showing anterior diaphragmatic attachments and subcostal incision. Site and direction of approach indicated by arrow. In this area the index finger inserted in the cleavage plane between the posterior rectus sheath and peritoneum will easily enter the left chest cavity.

bluntly detached from the costal arch, entering the pleural cavity anterior and superior to the plane of the diaphragm. (Fig. 1.) The size of this area varies widely in different subjects. From numerous cadaver dissections we have found it to measure from ½ inch up to several inches in subjects in whom the attachment of the diaphragm to the seventh costal cartilage is missing. The foramen of Morgagni (the fente d'Larrey of the French writers) lies immediately posterior to this area.

Another significant fact which develops importance in the closure of the approach to be described is that the diaphragm and the transversus abdominis muscle form a single continuous plane, their origins interdigitating on the deep surface of the lower six costal cartilages.

TECHNIC

As soon as the anesthetist has established the fact that cardiac arrest has occurred, his first duty is to warn the surgeon, controlled respiration under 100 per cent oxygen having been instituted. When a major artery is readily accessible, digital palpation by the surgeon will quickly verify cessation of pulsation. The operation, if it has started, is suspended forthwith. At this time the assistant may insert a spinal needle into the heart through the chest wall as recommended by the Lahey group.[1] This takes but a moment; a motionless needle will verify the diagnosis and the prick will occasionally be the stimulus to restore cardiac action. Under any circumstances, little time must be lost in preliminaries; the sooner the heart is reached and definitive treatment started, the better the patient's chance for survival.

The incision (Fig. 1), starting from the xiphisternal junction and paralleling the left costal arch as in the standard subcostal incision, is quickly carried down to the peritoneum, cutting through the rectus muscle and its posterior sheath and the underlying fibers of the transversus abdominis muscle. In its lateral part the external and internal oblique and the transversus abdominis muscle will be traversed. The peritoneum is not opened but it matters little if it is inadvertently entered. The posterior rectus sheath and transversus abdominis fibers are grasped and elevated as a single layer

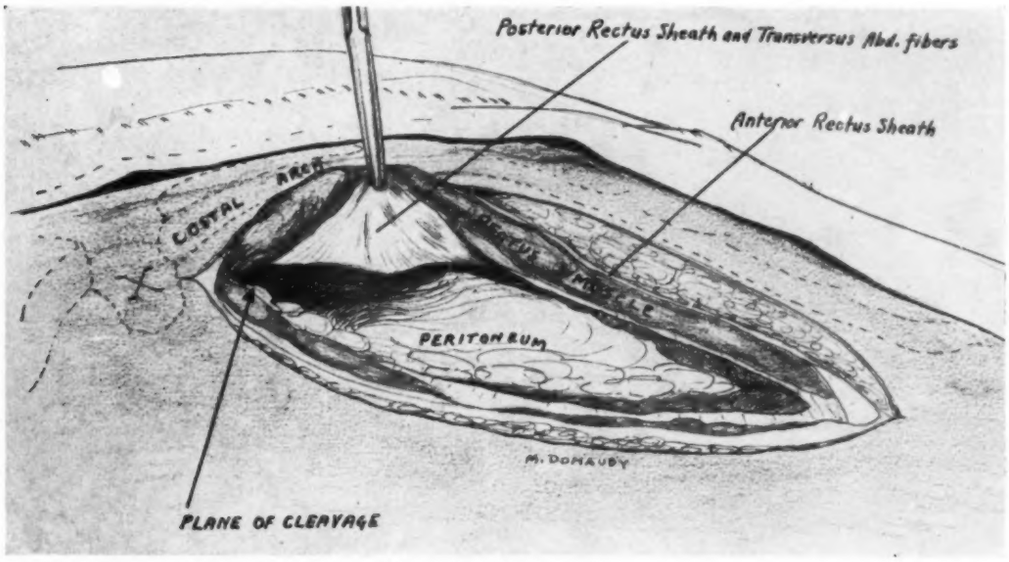

FIG. 2. Showing anatomy of infracostal approach. The plane of cleavage becomes evident when the posterior rectus sheath is elevated. This and the succeeding drawings are from photographs of actual dissections.

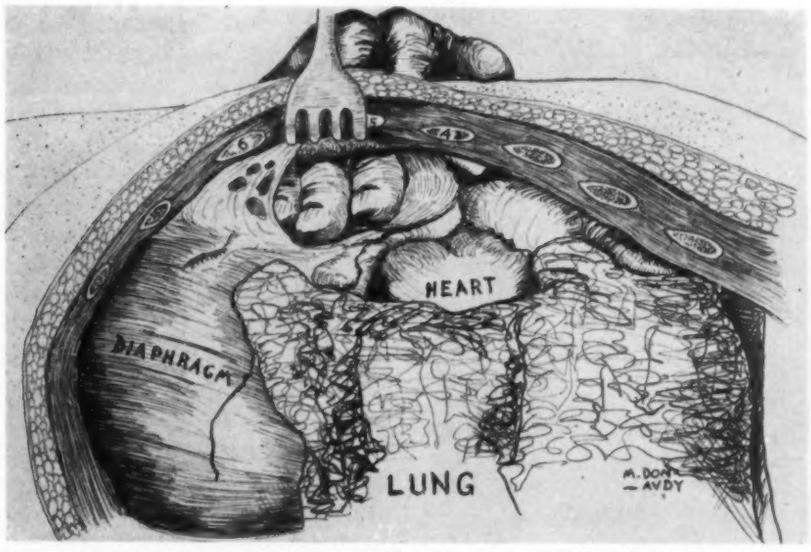

FIG. 3. View from opened thorax showing fingers depressing the diaphragm and perforating the pleural reflection while entering the left pleural cavity.

with tissue-holding forceps. (Fig. 2.) The right index finger is inserted in the plane *posterior to this layer and anterior to the peritoneum* just to the left of the xiphisternal articulation, hugging the internal surface of the costal cartilages. As the finger advances in the direction of the left shoulder, it will come to lie on the superior surface of the diaphragm between its sternal and costal origins. The parietal pleura is pierced almost without resistance. (Fig. 3.) The opening is rapidly enlarged laterally by the successive insertion of the third, fourth and fifth fingers. The entire hand now fits easily in the left pleural cavity, affording a very adequate grasp of the heart for effective cardiac massage. (Fig. 4.) The heart can be visualized by depressing the detached portion of the diaphragm and retracting the costal arch (Fig. 5), supplemented when necessary by enlargement of the opening achieved by a lateral sweep of the fingers. The pericardium can now be opened when advisable for the application of electrodes. In a rare instance it might be necessary to divide the costal arch for this procedure.

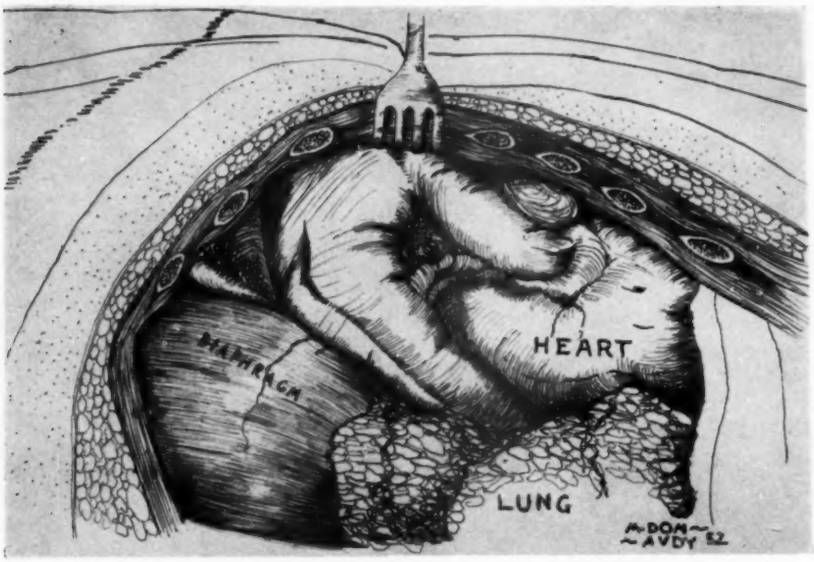

FIG. 4. View from opened thorax showing adequate grasp of heart for manual massage.

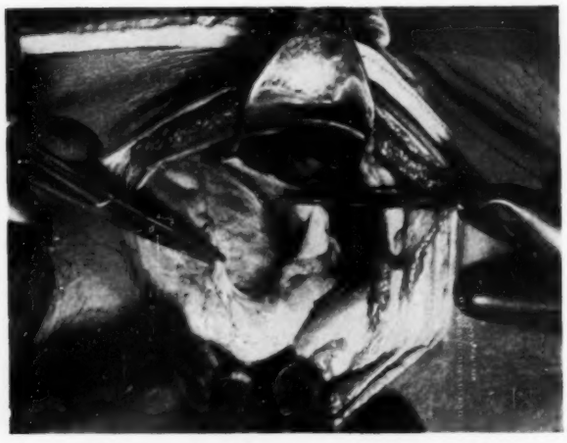

FIG. 5. Photograph of dissection showing adequacy of visualization of heart. The pericardium is being held open; electrodes may easily be inserted.

The rate at which the heart is massaged is subject to a wide difference of opinion. Most authorities recommend a rate of about 40 to 60 beats per minute as being adequate to maintain cerebral circulation. Others recommend rates varying between 20 and 120 beats per minute. Probably the best rate would be the fastest rate that could be maintained by the operator within the limits of fatiguability. The massage should be kept up, alternating operators when necessary, until spontaneous cardiac action begins or the patient is obviously beyond help. After restoration of the normal heart beat the lung is fully expanded under positive pressure by the anesthetist and direct vision of the surgeon. The chest is now closed.

Closure is accomplished by suturing the divided edges of the posterior rectus sheath and the transversus abdominis, including in the suture line the detached diaphragmatic origin. (Fig. 6.) This reconstitutes the normal anatomic relationship since the diaphragm and transversus abdominis interdigitate in their attachment to the inner surface of the lower six ribs. A catheter for water-sealed drainage of the pleural cavity may be placed at the lateral end of the incision. The remainder of the incision is closed in layers.

When cardiac arrest occurs in the course of an upper abdominal operation in which a left upper rectus incision has been used, the same approach as described in an earlier paper[2] is used. Here, since the incision has already been made, the operator simply separates the cut left edge of the posterior rectus sheath from the peritoneum adjacent to the xiphisternal articulation and proceeds as described heretofore. Because of the slightly different anatomy involved in this incision the closure is somewhat simpler since by suturing the peritoneum and the posterior rectus sheath as in the standard layer closure the chest cavity is automatically sealed off.

In cardiac arrest the primary object is to maintain the circulation, particularly the cerebral circulation. This is accomplished specifi-

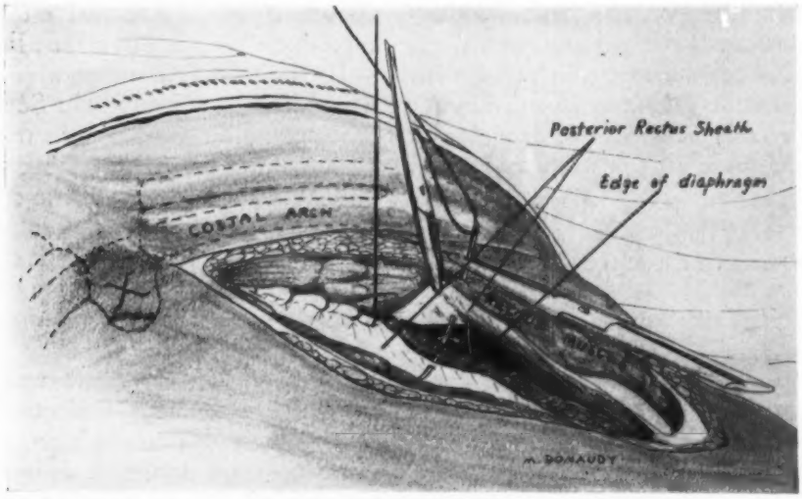

FIG. 6. Showing ease of closure. A catheter for water-sealed drainage of the pleural cavity may be placed at lateral end of incision.

cally by cardiac massage. In addition to cardiac massage various other measures are undertaken at the same time. Under controlled respiration the lungs are flooded with 100 per cent oxygen by the anesthetist. This should be continued after normal cardiac rhythm is reestablished for as long as is considered necessary by the anesthetist.

Cardiac arrest usually occurs as a diastolic ventricular standstill. In some cases the ventricle, rather than being perfectly flaccid, exhibits rapid purposeless and ineffectual fibrillary twitchings—the "bag of worms" sensation of ventricular fibrillation. The application of electrodes with electrical stimulation (110 volts A.C.) has been described as the treatment of choice here. Under any circumstances, cardiac massage must supplement this procedure and will often supplant it entirely when the electrodes are not immediately available. The development of a practicable instrument, using subcutaneous electrodes and employing 110 volts A.C. (for defibrillation) and a suitable pulsating direct current (for initiating cardiac action in standstill) as described by Zoll[3] would of course be the ideal method of treatment. Unfortunately, situations will arise in which such an instrument, even when perfected, will not be available; here we must depend on cardiac massage.

ADJUVANT MEASURES

Apart from cardiac massage and oxygenation, other measures are undertaken simultaneously. Placing the patient in the Trendelenburg position (10 to 15 degrees) may help cerebral circulation by its purely gravitational effect. Administration of fluid, especially blood, given preferably intra-arterially (intra-aortic or intracardiac) may give dramatic results.

Detailed discussion of the various drugs used in cardiac arrest is beyond the scope of this paper. The use of procaine, epinephrine, calcium chloride, barium chloride, potassium chloride, nikethamide, etc., alone or in combination, each has its advocates. Epinephrine with its powerful myocardial stimulant effect is probably the most widely used medication. Its tendency to produce ventricular fibrillation must be borne in mind. The well known effect of procaine in decreasing the irritability of the cardiac musculature has led to its almost universal acceptance, usually in a dosage of 10 cc of 1 per cent solution. The combination of 0.5 cc. of 1 : 100 epinephrine and 9.5 cc. of 1 per cent procaine is favored by some authors.[4] Calcium chloride in a dosage of 2 to 4 cc. of 10 per cent solution may be effective where other medications have failed.[5] These drugs are administered by the most expeditious route, which may be intracardiac, intra-arterial (or intra-aortic) or intravenous. The use of other medications is still not fully accepted.

At the Southside Hospital a plainly marked Cardiac Resuscitation Tray is kept at the anesthetist's station in each operating room. Each tray includes the following: six straight and six curved hemostats; two scalpels; one pair of dissecting scissors; two toothed forceps; two Mayo retractors; one 10 cc. syringe filled with

1 per cent procaine, the syringe tip rubber-capped; one 10 cc. ampul 1 per cent procaine; two 1 cc. ampuls 1:1000 epinephrine; one 10 cc. ampul 10 per cent calcium chloride; two 2 cc. and two 10 cc. syringes; two spinal and two No. 20 gauge needles; one ampul file; and one set of electrodes. A single tray for an entire operating suite is inadequate since valuable time will be lost in securing it in a situation where seconds count. Our experience with cardiac arrest has led us to formulate a definite plan of procedure when this catastrophe occurs. All operating room personnel have been instructed in the location of the tray and its contents, and the entire surgical staff has been familiarized with the infracostal approach. When it is apparent that cardiac arrest has occurred, the plan as outlined in Table 1 immediately comes into play.

TABLE 1

PLAN OF ACTION IN CARDIAC ARREST

Anesthetist:
- (1) Notifies operating surgeon
- (2) Controlled respiration with 100% oxygen
- (3) Patient in Trendelenburg position
- (4) Blood and fluids
- (5) Medication:
  - Procaine
  - Epinephrine
  - Calcium chloride

Circulating nurse:
- (1) Opens Cardiac Resuscitation Tray
- (2) Connects defibrillator
- (3) Acts as timekeeper

Sterile nurse:
- (1) Opens ampuls and loads syringes
- (2) Assists surgeon as needed

Assistant surgeon:
- (1) Inserts spinal needle into heart through chest
- (2) Alternates with surgeon in massage

Surgeon:
- (1) Leaves operative field
- (2) Infracostal approach
- (3) Manual cardiac massage and electrodes as indicated

The defibrillator need not be very elaborate. Our home-made outfit consists simply of a mercury spark-proof switch which controls an outlet of 110 volts a.c., a small pilot light being included in the circuit to indicate when the current is flowing. The electrodes, with a 6 foot length of insulated wire and male plug, are kept sterile in the Cardiac Resuscitation Tray. In use, the plug would be inserted into the outlet, *being certain that the current is off*. After the electrodes have been placed in position, the switch is quickly flicked on and off. Only a momentary surge of current is used.

In the past four years nine cases of cardiac arrest have occurred at the Southside Hospital. Although only one patient survived, we believe that definite progress has been made since the earlier cases; and should the catastrophe occur again, we believe the patient's outlook would be definitely better as a result of planned action.

A brief résumé of the nine cases follows:

CASE REPORTS

CASE I. This patient was a thirty-three year old man with atelectasis. As the oto-laryngologist was introducing a bronchoscope, cardiac arrest occurred. A call was sent over the loudspeaker system for a surgeon; on arrival he promptly opened the abdomen and instituted cardiac massage through the intact diaphragm without effect. The patient expired on the operating table.

CASE II. The patient was a five year old girl with a fractured jaw and multiple injuries. The oral surgeon was wiring her jaw when cardiac arrest occurred. Considerable time was lost before the general surgeon arrived. Tracheotomy for respiratory obstruction was performed, followed by massage of the heart using the infracostal approach. Heart action was not restored and the patient was pronounced dead after twenty-five minutes.

Comment. In Cases 1 and II the long delay in securing a surgeon probably contributed to the fatality, although in Case II autopsy showed evidence of pulmonary damage.

CASE III. The patient was a sixty-two year old man who had a carbuncle of the neck. Cardiac arrest occurred during induction. The operating surgeon opened the abdomen and manually massaged the heart through a diaphragmatic incision for twenty minutes, with restoration of normal cardiac rhythm. Death occurred two hours later, without the patient recovering consciousness.

CASE IV. This forty-three year old woman was attended for multiple tooth extractions. She became cyanotic during endotracheal intubation. Cardiac arrest was noted fifteen minutes later. A surgeon in an adjacent operating room was summoned. Using the infracostal approach, cardiac massage was actually being performed "within thirty seconds" of the time of incision. Heart action returned after three or four minutes and was maintained for sixty-

five hours although the patient expired without regaining consciousness.

Comment. In Cases III and IV reasonably prompt action by the surgeon restored heart action; here apparently delay in diagnosis caused fatal cortical anoxia.

CASE V. This patient, a sixty-eight year old woman, was hospitalized for intestinal obstruction. Cardiac arrest occurred before incision was made. The abdomen was opened and the heart massaged through the intact diaphragm. Heart action was not re-established and the patient expired on the operating table.

CASE VI. This patient, a seventy-five year old man, had prostatic hypertrophy. Cardiac arrest occurred as the prostate was being enucleated. The urologist summoned a general surgeon who opened the abdomen and massaged the heart through a diaphragmatic incision for fifty minutes; the heart action was not re-established and the patient expired on the operating table.

Comment. Cases V and VI were both bad-risk patients. In Case V the patient was a severe diabetic in poor condition from a long-standing intestinal obstruction. In Case VI the patient had a badly damaged heart with marked hypertension. Neither of these responded to cardiac massage; pre-existing damage to vital organs probably precluded restoration of normal heart action.

CASE VII. This fifty-six year old man had suffered multiple injuries. He was treated with open reduction of the fractured patella and ankle, and wiring of the fractured jaw under spinal anesthesia (pontocaine in glucose, 1 cc. vasoxyl).

The operation on the leg was performed without incident in one hour. For the subsequent jaw wiring, with only the oral surgeon and anesthetist in attendance, 14 cc. of 2½ per cent pentothal® were administered intravenously. Curare, 1 cc., was administered and 2 per cent pontocaine applied topically for endotracheal intubation. Cardiac arrest occurred during introduction of the tube. The surgeon, who had left, was hurriedly recalled and promptly instituted cardiac massage using the technic described. Normal cardiac rhythm was re-established after fifteen minutes of manual massage, during which coramine and epinephrine were administered both by vein and directly into the heart. Spontaneous respiration had been re-established within twenty-five minutes of the time the cardiac arrest was announced. The wound was closed, the chest aspirated of air and a tube for water-sealed drainage inserted. An electrocardiogram shortly afterward showed normal sinus rhythm. Four hours later, because of persistent respiratory obstruction (the fractured jaw had not been repaired), tracheotomy was performed with very noticeable improvement. Deep coma persisted, however; and although on the third and fourth days the coma appeared to be lightening, on the fifth post-operative day there was a sudden temperature rise with death.

Comment. Ironically, this patient was the surgeon who had operated upon two of the earlier cases in this series. Although the operating surgeon promptly and decisively instituted cardiac massage, the delay in his arrival was undoubtedly a factor in producing the fatal cerebral anoxia in spite of restoration of normal sinus rhythm.

CASE VIII. This sixty-two year old man underwent subtotal gastrectomy for gastric ulcer. Anesthesia used was: spinal (pontocaine 15 mg. in dextrose); pentothal® .2 per cent intravenously; nitrous oxide-oxygen.

Cardiac arrest occurred as the gastrectomy was being completed, about one and a half hours after anesthesia had begun. Immediately on notification of cardiac arrest heart massage was begun using the infracostal approach. Ventricular fibrillation which supervened was controlled by intravenous injection of 10 cc. of 1 per cent procaine. After an estimated seven minutes of cardiac massage regular sinus rhythm was re-established. Epinephrine, 0.2 cc. of 1:1000 solution, was given intravenously. The pulse became stronger and regular with a rate of 82. A total of 1,500 cc. of blood was given. Controlled respiration was continued for one hour. The operation was concluded and the patient was returned to his room four hours after start of anesthesia, still in deep coma. Over the next twenty-four hours a total of 360 cc. of normal salt-poor human albumin was administered without significant change. In spite of vigorous supportive measures the patient did not fully recover consciousness and expired fifty-six hours after the cardiac arrest had occurred.

Comment. This case, which has been described in considerable detail elsewhere,[2] was the basis of the development of the infracostal approach. The senior author, confronted with

the sudden cardiac arrest, instinctively pushed his hand upward in the plane posterior to the posterior rectus sheath (the abdomen having been opened by an upper left rectus incision) and found that the left chest cavity was easily entered. Numerous subsequent cadaver dissections established the anatomic basis of the approach.

CASE IX. This fifty-two year old woman underwent hysterectomy for uterine fibroids. Anesthesia used was: pentothal intravenously; spinal (14 mg. pontocaine in glucose, 10 mg. vasoxyl).

While the uterine arteries were being ligated, the anesthetist announced that the heart had stopped. The surgeon immediately made a subcostal incision and instituted cardiac massage through the infracostal approach. Normal cardiac rhythm was restored after a short period of massage. The lung was re-expanded and the infracostal incision closed without drainage. The hysterectomy was then completed without further incident. The patient did not recover full consciousness until sixteen hours later; during the latter six hours of this period she exhibited frequent generalized clonic convulsions. After recovering full consciousness, she had generalized tremors, spasticity of the legs, mild convulsive seizures and aphasia.

At the time of discharge from the hospital ten days postoperatively the patient was quite well physically and mentally but she exhibited evidence of damage to the striopallidal cortical area, i.e., spasmodic and uncontrollable motions, especially of the right arm.

Six months later these neurologic signs were still present although in a lesser degree; her mentality was quite normal and she was otherwise well.

Comment. This patient, our most recent case, is the only one of the series to survive. The persistent neurologic signs indicate that the difficulty here was in diagnosis. The surgeon had instituted manual cardiac massage within thirty seconds of notification; by then the inexorable time limit for cortical damage had already been exceeded.

SUMMARY AND CONCLUSIONS

The infracostal approach for manual massage of the heart in cardiac arrest, with a brief presentation of the adjuvant measures useful in cardiac resuscitation, is discussed. As the case presentations show, this dire emergency may arise in any surgical subspecialty; and the infracostal approach, once learned, can be used with little hesitation by those unaccustomed to working in the thoracic or abdominal cavities. The method involves entering the chest through a left subcostal incision which allows access to the heart through a natural plane of cleavage lying posterior to the posterior rectus sheath and transversus abdominis muscle, and anterior to the peritoneum adjacent to the xiphisternal junction. Brief reports of the nine cases of cardiac arrest which occurred at the Southside Hospital in the past four years are presented, together with the plan of action which has been developed. Early diagnosis and prompt, decisive treatment by the surgeon using the infracostal approach (which we prefer), or any other approach, is necessary if we are to save lives that may be needlessly lost.

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PHEOCHROMOCYTOMA*

JOSEPH L. DECOURCY, M.D.
Cincinnati, Obio

ONCE thought extremely rare, pheochromocytoma has recently been found to be the most common surgically curable cause of high blood pressure.[1–20] Other surgically curable forms of hypertensive disorders are encountered but far less frequently: hypertension due to unilateral renal disease (curable in some patients who have an adequately functional contralateral kidney), and hypertension due to coarctation of the aorta, brain tumor, adrenocortical tumor, certain pituitary neoplasms and certain tumors of sympathetic nerve tissue, only a few hypertensive cases of which have been recorded.

A pheochromocytoma is a chromaffin cell tumor of the adrenal medulla or of other chromaffin tissue such as in the lumbar or thoracic paravertebral spaces, in the organ of Zuckerkandl, ventral to the great vessels of the abdomen, in the celiac ganglion or wherever chromaffin tissue is found during embryologic development as well as at maturity.

Hypertension due to secretion of epinephrine and/or nor-epinephrine by a pheochromocytoma must be considered as a possibility in every patient found to have high blood pressure. The elevation of blood pressure may be persistent or paroxysmal or both, as in the patient whose history is to be related. In fact, pheochromocytoma is the "great mimic" among hypertensive disorders.

"Although the incidence of pheochromocytoma found in a series of hypertensive patients is low (0.5 per cent), it nevertheless becomes quite significant when one considers the extremely high incidence of hypertensive diseases in general."[15] According to Graham: "In the United States more than 800 patients die annually of this disease; most of these are avoidable deaths."

And, as stressed by Iseri and his associates: "The recognition and the ultimate diagnosis of this condition are essential since definitive treatment offers a reasonable assurance of cure in an otherwise progressive and eventually fatal disease."[15]

The following case history is unusually instructive, it is believed, because it illustrates the common failure to consider the possibility of pheochromocytoma whenever the problem of persistent hypertension is presented, and in addition shows the difficulties of diagnosis, localization and surgery which are often encountered.

CASE REPORT

A forty-nine year old married white woman entered the Good Samaritan Hospital (Case No. 15018W)† in acute distress because of extreme weakness, symptoms of cardiac failure, severe headaches and extreme nervousness.

The patient was flushed and perspired profusely. The pulse was very rapid, 176 per minute, but had a regular rhythm. The respiration rate was about 30 per minute and regular. The blood pressure was 260 systolic and 160 diastolic. The heart sounds were forceful and loud (pounding). No murmurs were heard. The heart was enlarged to the left. The electrocardiogram showed non-specific abnormalities besides alterations attributable to tachycardia. The liver and spleen were not palpable. The abdomen was soft and no masses were felt. Ophthalmic examination disclosed slight haziness of the disc margins, and tortuous and sclerotic arteries. A few hemorrhages were noted. Otherwise, examination of the patient yielded essentially negative findings.

Laboratory determinations of significance were as follows. Fasting blood sugar was 138 mg. per 100 cc.; on another occasion a few days later it was 150 mg. per 100 cc. The oral glucose tolerance curve was 163 after one hour, 190 after two hours and 182 mg. per 100 cc. after three hours. Only traces of sugar appeared in the urine. Phenolsulfonphthalein excretion was 18 per cent after one hour, 38 per cent after two hours and 52 per cent after three hours.

The patient, who had previously been seen

† The author is indebted to William F. Freyhof, M.D., for referring this patient to him.

* From the DeCourcy Clinic, Cincinnati, Ohio.

by various physicians, was found to have had severe hypertension (more than 260 mm. Hg systolic on certain occasions) for at least five years.

Nine months before the present admission the patient had undergone a minor operation on the right breast and postoperatively experienced hypertensive paroxysm, with a pulse rate of 180, profuse sweating and cardiac failure. Rapid digitalization was followed by a fall in blood pressure (but not to normal range) and subsidence of other symptoms.

Subsequently, on various occasions the patient's blood pressure was observed to be extremely labile, showing marked rises and declines while remaining persistently above normal. At the same time headaches became increasingly frequent and severe, and nervousness and apprehension also increased.

The present hypertensive and cardiac attack was believed to have been precipitated by emotional stress due to illness and death in the patient's family and to the sudden news that her son was going into the army. When this news had been received on the day before admission, the patient suffered a severe headache, became extremely upset and experienced a sensation of generalized numbness besides perspiring profusely and flushing conspicuously.

A diagnosis of "malignant hypertension" had previously been made by various physicians during the past five years and was obviously still to be considered seriously in view of the symptoms and progressive nature of the disorder. It was also recognized, however, that the very same symptoms are often associated with pheochromocytoma and that a differential diagnosis was imperative. If a chromaffin cell tumor were present and its location could be accurately determined, surgery might prove life-saving.

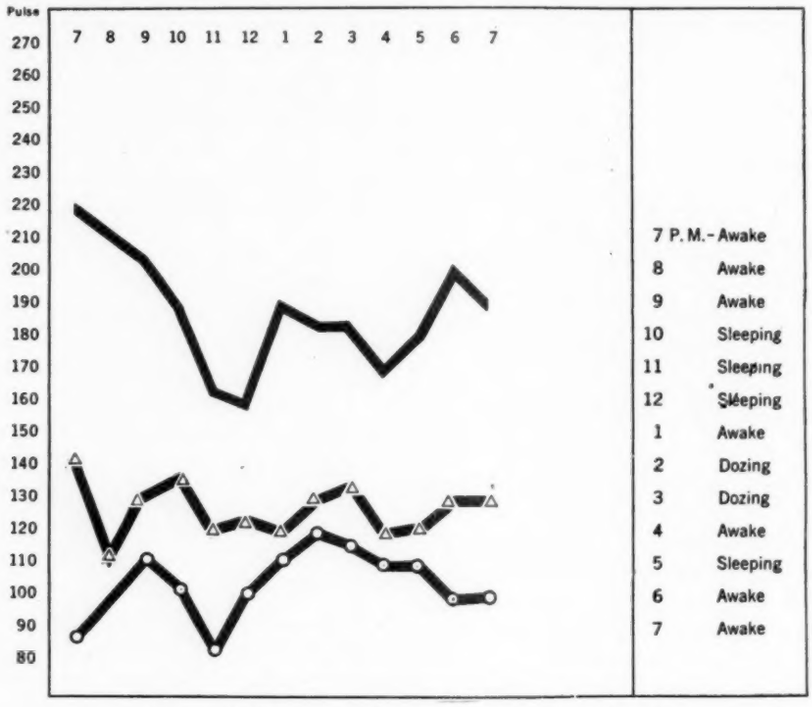

FIG. 1. Sodium amytal test, 3 gr. at 7, 8 and 9 P.M.

Films of the urinary tract revealed numerous small areas of calcification in the right upper quadrant and another small area of calcification in the vicinity of the left suprarenal area, but no other evidence of tumor. Intravenous excretion urograms showed functioning kidneys without evidence of hydronephrosis or stone.

Although gallbladder visualization to rule out cholelithiasis was not feasible so precarious was the patient's condition, the areas of calcification in the right upper quadrant aroused suspicion of the possible presence of chromaffin tumor in relation to the right adrenal while it was also assumed to be possible that (1) a bilateral tumor existed and (2) a tumor was present in relation to the left adrenal gland, with coexistent cholelithiasis. No tumor mass

could be felt, however, and the patient manifested no intensification of symptoms following gentle pressure (exerted during light palpation) just above the kidney on either side. Massage of the adrenal area could not be ventured because of the serious condition of the patient.

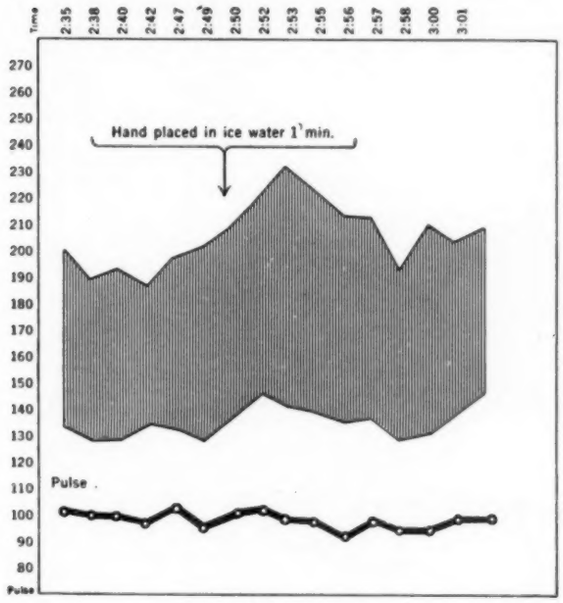

FIG. 2. Cold pressor test.

Perirenal air injection and retrograde pyelography were for the same reason adjudged excessively hazardous.

In the light of the patient's symptoms and history, as well as the evidence of areas of calcification apparently in the vicinity of the adrenal gland on each side, the results of the following tests led to the conviction that pheochromocytoma was present, actively secreting epinephrine and/or nor-epinephrine:

Following administration of sodium amytal (3 gr.) at 7, 8 and 9 P.M., the systolic pressure declined from 220 at 7 P.M. to 160 at midnight, thereafter rising to 190 at 1 A.M. (Fig. 1.) A drop to 170 occurred as the patient dozed or slept between 3 and 5 A.M. At 6 A.M. the patient was awake, with a systolic pressure of 200. The diastolic pressure showed the following changes:

7 P.M.—90	11 P.M.—85	2 A.M.—120
8 P.M.—100	12 P.M.—100	4 A.M.—110
9 P.M.—110	1 A.M.—110	6–7 A.M.—100

It was considered possible that the temporary decline in blood pressure might be attributed to partial relief of psychic tension, so that discharge of hypertensive agents from the tumor was diminished. Like similar paroxysms in patients with these tumors, the present hypertensive attack appeared to have been precipitated by emotional stress. Presumably a greater fall did not occur, especially in the diastolic pressure, because of insidious

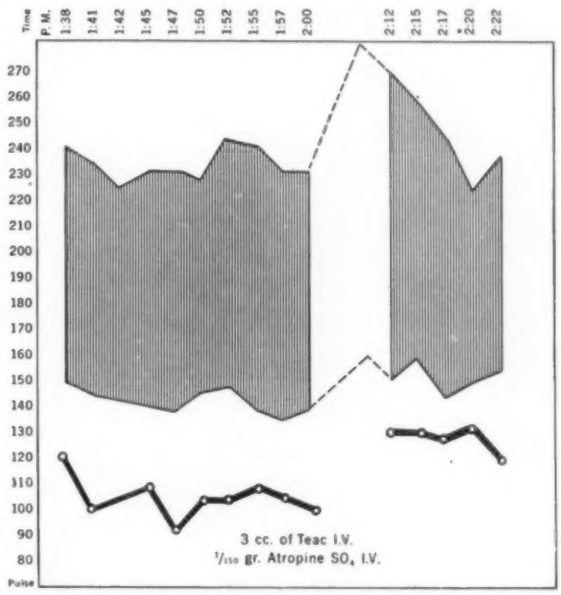

FIG. 3. Tetraethylammonium chloride test. Blood pressure off the scale. Patient apprehensive, pulse unobtainable, neck veins dilated.

progress of the disorder to the phase in which renal involvement had resulted in persistent hypertension. It is also conceivable that the pheochromocytoma (assuming that it was present) had a more or less steady *basal* rate of secretion of epinephrine and/or nor-epinephrine despite sedation.

The immersion of one hand in ice water for one minute produced an "essentially normal" response, i.e., an evanescent rise of about 20 mm. in the systolic and less than 15 mm. in the diastolic pressure. According to Smithwick et al.,[20] "a normal response to cold in a hypertensive patient is unusual and should cause one to consider the possible presence of a pheochromocytoma." (Fig. 2.)

Immediately after the intravenous injection of 100 mg. of tetraethylammonium chloride (in 3 cc.) the blood pressure rose alarmingly to such a high level as to make determination impossible. The pulse rate also was unobtainable. The neck veins were dilated. The patient became apprehensive in the extreme. Prompt injection of atropine sulfate ($\frac{1}{150}$ gr.) induced

a rapid fall in both systolic and diastolic pressures; within ten minutes the systolic pressure had declined to 235, and the diastolic to 150. (Fig. 3.)

Obviously this test—like the histamine test—must be considered far too hazardous for routine use, if its use is justifiable at all. Safer tests are now available.

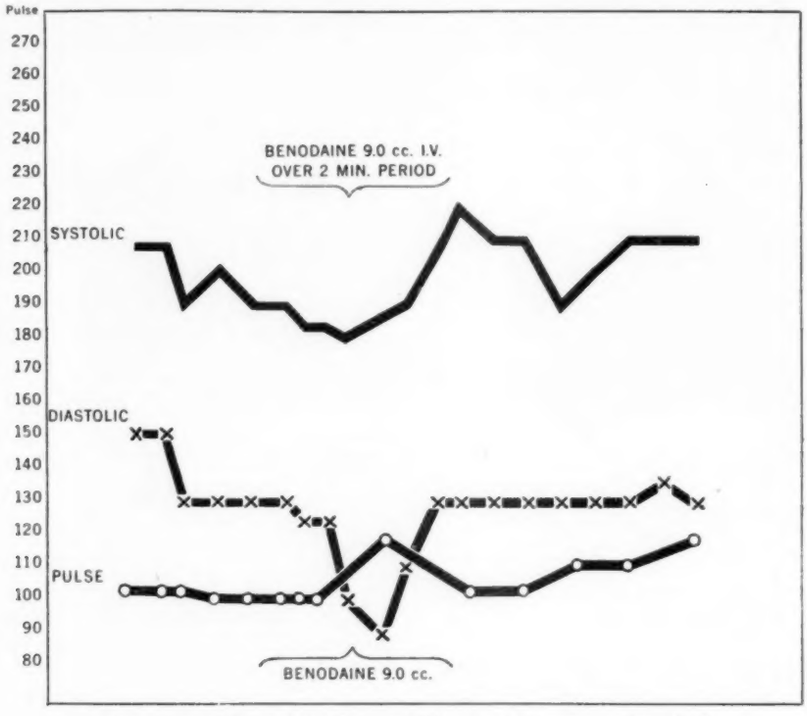

FIG. 4. First benodaine® test. Thirty-minute control period.

Two tests were performed with piperoxan hydrochloride; the second test after an interval of three days. In each test 18 mg. (9 cc.) of a preparation of piperoxan hydrochloride was injected intravenously, slowly over a two-minute period.

In the first test during a thirty-minute period of preliminary observation the systolic pressure declined from 210 to 185 and the diastolic from 150 to 125, i.e., *before the injection*. During the two-minute period of injection a fleeting decline of the blood pressure to 160/90 occurred and was immediately followed by a rise to 220/130. (Fig. 4.)

The second test was done three days later. During the fifteen-minute period of observation just prior to the injection of piperoxan the systolic pressure became stabilized at 230, and the diastolic at 140. While the injection was being made, the systolic pressure fell to 190, and the diastolic to 110; but as the injection was completed, the blood pressure rose rapidly to 250/150. (Fig. 5.)

These responses, although conspicuously unlike those described by some as "typical" of patients with pheochromocytoma, were at the same time abnormal and presumably indicative of the pressure of excessive titers of circulating epinephrine and/or nor-epinephrine.

The patient remained profoundly ill and failed to respond to rest and other indicated measures. It was apparent that she would continue her downward course unless surgery could avail as an ultimate recourse. It was hoped that in spite of the patient's precarious state removal of actively secreting chromaffin tumor tissue would, as in other cases in our experience and in many reported cases, result in prompt and dramatic improvement.

Although just prior to operation the systolic pressure was 210 and the diastolic 120, and although it was assumed that unavoidable trauma and manipulation of the tumor would probably cause an increase in the discharge of hypertensive substances from the pheochromocytoma, it was deemed decidedly inadvisable to use piperoxan to lower blood pressure during surgery. The two tests with this had demon-

strated the patient's response to such injections to be a fleeting reduction in blood pressure immediately followed by a sharp rise to pre-injection levels or higher.

At operation the incision was unfortunately made on the right side, considerably more pheochromocytomas having been found on this side than on the left.[12] The patient's condition precluded bilateral exploration at the time.

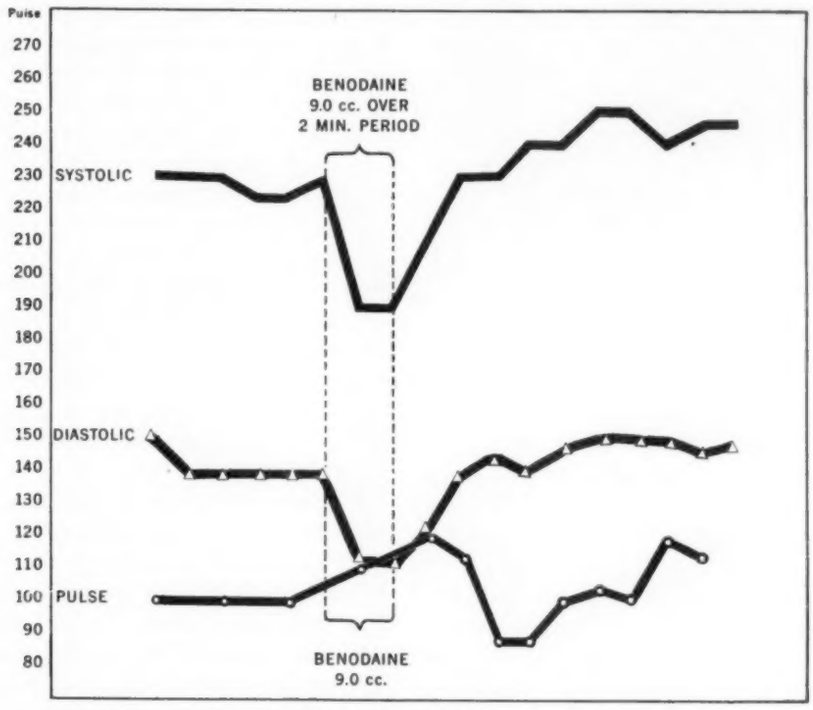

FIG. 5. Repeat benodaine test. Fifteen-minute observation.

No tumor was found and the incision was closed. During the operation the patient's blood pressure rose to 280/200. Postoperatively the pulse rate was 170 and the blood pressure increased to 300/200 then gradually fell to 220/160, at which level it remained for about an hour. Afterward, a further fall to 180/140 occurred but the patient rapidly became cyanotic and dyspneic, and shortly thereafter expired from ventricular failure.

At autopsy a firm mass 4 by 5 by 7 cm., encapsulated and surrounded by two ureters, was found as an outgrowth from the left adrenal gland. The tumor was situated at the mid-portion of the kidney in the posterior aspect. In cut section the mass was yellowish, with hemorrhagic areas. Histologic examination revealed typical chromaffin tumor cells. (Fig. 6.)

The kidneys showed marked arteriolar sclerosis with involvement of some of the glomerular tufts. No significant nephrosclerosis was present. Marked arteriolar sclerosis was also found in the perirenal and retroperitoneal fat, in the spleen and in the pancreas. The liver showed mild, chronic, passive congestion and pericholangitis with moderate sclerosis of hepatic arterioles. The heart was enlarged, with extreme dilatation of the left ventricle; the coronary arteries showed slight sclerosis. The left ventricle wall measured 5 cm. Extreme edema was shown by the lungs, hypostatic congestion being marked, with incipient lobular pneumonia.

COMMENT

It is now becoming more and more widely recognized that: "Pheochromocytoma . . . should be considered in all cases of hypertension."[8] *Already, in fact, consideration of this possibility must be regarded as a definite obligation of the physician to every hypertensive patient.*

It would appear a clearly justifiable assumption that had the possibility of pheochromocytoma been taken into account five years earlier in the case presented herein, the tumor could have been removed with a minimum of

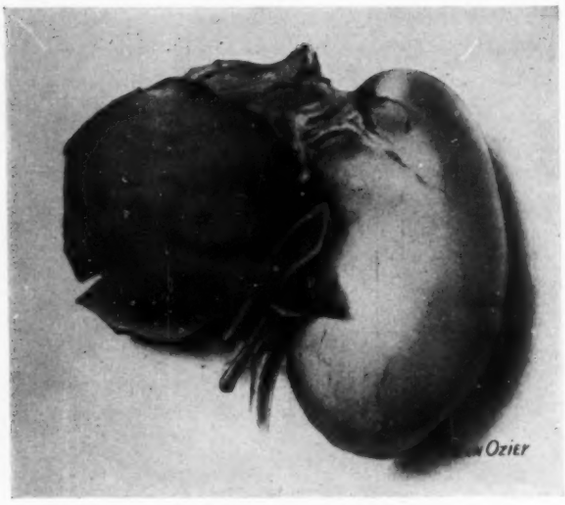

FIG. 6. Suprarenal tumor with accessory ureter.

risk under the most propitious circumstances. Although always hazardous in the presence of such a tumor, even perirenal air injection as well as retrograde pyelography might have been feasible before the disease was far advanced. Certainly, during the years prior to death, at various times the patient was virtually symptom-free, except for a persistently elevated blood pressure, and apparently in good general physical condition. At such a time, in all probability, bilateral exploration could have been safely carried out and the tumor discovered and excised. (The case just recorded represents the only death in our series of thirty-one adrenalectomies, including three cases of pheochromocytoma and twenty-eight of malignant hypertension.)

Three Types of Hypertension Associated with Pheochromocytoma.[1–20] *Sustained hypertension* is manifested by a large percentage, perhaps the majority of patients with pheochromocytoma, and is attributable to a rather constant discharge of epinephrine and/or nor-epinephrine from the tumor. The symptomatology closely resembles that of essential hypertension.[11,19]

Paroxysmal hypertensive episodes, apparently due to intermittent discharge of considerable quantities of epinephrine-like substances from the tumor, are experienced by many patients. The attacks may be very brief or may last for days, and the intervals between attacks may vary from a few minutes to many months. As the disease progresses, the blood pressure between attacks ceases to return to normal and becomes fixed at a higher level, suggesting a diagnosis of essential hypertension or malignant hypertension.[11,19]

Fluctuating blood pressure but without true paroxysms may be manifested by some patients with such tumors, and elevations of blood pressure may not be closely associated with symptoms.[11,19]

Uncertainty and Risk of Older Diagnostic Tests. Because diagnosis of pheochromocytoma on the basis of clinical manifestations is most often impossible (however strongly the symptoms may suggest the presence of such a tumor), recourse must be had to diagnostic tests. Two types of diagnostic tests involving the use of drugs are available: (1) attempted induction of a hypertensive paroxysm by stimulating a discharge or increased discharge of hypertensive substances (epinephrine and/or nor-epinephrine) from the tumor; and (2) attempted reduction of elevated blood pressure by means of a drug which specifically blocks the hypertensive effects of epinephrine-like substances.

Histamine, tetraethylammonium chloride or bromide, and acetyl-beta-methylcholine have been used to precipitate paroxysms, but at great risk, as shown by the deaths recorded.[11] The hazard of tetraethylammonium chloride was demonstrated in the present case. A positive response may be accompanied by such a rise in blood pressure as to produce a cerebrovascular accident or cardiac failure. Besides, false positives and false negatives do occur with these dangerous drugs.[1,10,11]

Although piperoxan ("933F" or benzodioxane) has been used as a testing agent having adrenergic blocking capacity, the "positive response," reduction of blood pressure, is fleeting and may escape detection even in severe hypertension due to pheochromocytoma. In fact, in the present case, blood pressure rose rapidly at the very instant the injection was completed. Recent reports have emphasized the frequent occurrence of false positives and false negatives, as well as quickly evanescent, ambiguous drops in pressure following the administration of piperoxan.[1,4,5,7,9,15–17,20] Severe, alarming reactions, particularly hypertensive paroxysms, must be expected in a considerable percentage of patients with essential hypertension or malignant hypertension.[4,7,12,17]

Recently, however, phentolamine has been found to be virtually a specific as well as quite safe testing agent, as reported by Grim-

son and his associates,[9,13] and Roth and her associates.[18] According to Grimson, the phentolamine test should become routine,[9] as at the Mayo Clinic (Roth[18]) and other clinics.[14]

Control of Blood Pressure before and during Surgery. Phentolamine now also affords for the first time an adrenergic blocking agent capable of controlling blood pressure in patients with pheochromocytoma as a vital measure in preoperative preparation of the patient, the drug being effective orally as well as parenterally.[6,8,13,14,18,21] Control of blood pressure during removal of the tumor by repeated injections of the drug as blood pressure rises may likewise be regarded as a new advance. Had this drug been available, perirenal air injection and retrograde pyeolography as well as surgical exploration bilaterally might have been safely performed in the present case and cardiac failure during surgery might well have been avoided.

Anesthesia and Surgical Approach. Spinal anesthesia in our opinion is definitely indicated in these patients. When the tumor can be located prior to operation (and every feasible effort should be made to do so), the lumbar approach on the affected side is undoubtedly best; transverse abdominal incision has not proved satisfactory in our experience. The double lumbar incision is not always feasible, as in the present case, but may be possible if blood pressure can be safely controlled.

CONCLUSIONS

1. Careful consideration of the possible presence of pheochromocytoma in every patient with hypertension must now be regarded as a diagnostic obligation.

2. The hazard associated with the use of histamine, tetraethylammonium and other agents capable of precipitating paroxysms in patients with pheochromocytoma must be regarded as excessive and such tests unjustified unless a potent adrenergic blocking agent such as phentolamine is available for prompt control of the induced attack.

3. Recent advances indicate probable improvement in preoperative and operative measures for surgical treatment of this disease.

4. All feasible efforts must be made to locate such a tumor prior to surgery. Once the tumor is located, generally the lumbar approach on the affected side is preferable to transverse abdominal incision.

5. Early diagnosis, appropriate preoperative preparation and prompt surgical removal may be expected to result in cure of this hypertensive disorder in almost 90 per cent of patients.

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Acute and chronic effects are produced in skin subjected to irradiation. Irradiated skin presents several changes: vascular changes affecting the stroma and producing ischemica, acanthosis, atrophy, hyperkeratosis, etc. According to Telch, dysplasia of the epithelial cells is an early stage in carcinomatous degeneration due to irradiation. The sebaceous glands, the erector muscles of the hairs and the hair follicles themselves seem especially sensitive to irradiation whereas the sweat glands seem more resistant to injury by such means although they undergo atrophy if more irradiation is given. Even when cancer of the skin followed irradiation, the malignancy appeared to be localized by a condensation of the surrounding stroma. (*Richard A. Leonardo, M.D.*)

NEPHRECTOMY AND HYPERTENSION*

THE EXPERIENCE IN ONE UROLOGIC CLINIC

COMDR. STANLEY J. OKULICZ, M.C. AND VICTOR F. MARSHALL, M.D.
New York, New York

NEPHRECTOMY for the principal indication of hypertension has been carried out only rarely in the urologic services of the New York Hospital. Smith[1] in reviewing 242 cases of nephrectomy upon hypertensive patients accepted forty-seven (19 per cent) of these as being successful, regarding the blood pressure (one or more years of postoperatively normal tension). A review of our experience should provide indications as to whether our conservative policy should be modified.

From 1940 to 1950, 780 nephrectomies were performed. The indication in 170 of these cases was cancer. Because this indication was absolute from the time of diagnosis these 170 were omitted from this review. Forty-eight (8 per cent) of the remaining 610 patients had repeated observations of blood pressures in excess of 140/90. A few others probably had hypertension but the records did not permit a positive classification. In addition the records of thirteen of these forty-eight hypertensive patients who underwent nephrectomy for non-cancerous disorders were inadequate for a critical evaluation of the possible effect of the operation upon the blood pressure.

Accordingly there are thirty-five determinate cases. Upon these a re-evaluation of our conservative policy largely depends. No significant change has been noted in eleven cases (31 per cent), and in five others (14 per cent) the hypertension progressed so that death occurred between one and seven years after operation. In fourteen cases (40 per cent) there is some suggestion of a lessening of the hypertensive disorder but the evidence will not stand on critical review. In other words, in thirty of the thirty-five cases no clear indication of a beneficial effect on the vascular disease was found. In the remaining five cases (14 per cent) some definite diminution in the hypertensive disorder did occur, but only two of these appear as cures. By cure is meant persistently normal blood pressure for two or more years and relief of symptoms. Thus only 14 per cent of the patients, seem to have benefited in regard to the hypertension, and only 6 per cent were cured.

CASE REPORTS

CASE 1. M. H. (New York Hospital No. 267610) was a fifty-two year old man with a blood pressure of 190/100 mm. of mercury. For the preceding three to four years severe morning headaches had required analgesics almost daily. His family physician had discovered hypertension (degree not known) two years before admission to the hospital. The patient had had unexplained episodes of fever lasting several days about every six weeks for twelve years. An infected left hydronephrosis with decreased function was demonstrated. The right or good kidney concentrated urea to 5 gm./L. and excreted 7 per cent of intravenous phenolsulphonphthalein in ten minutes after a two-minute delay, while the left or diseased kidney simultaneously concentrated 2 gm. of urea/L. and excreted 4 per cent of phenolsulphonphthalein ten minutes after a two minute delay. Repetition of these studies a few days later confirmed these differences. Urine cultures found Bacillus proteus and Bacillus lactis aerogenes. The left kidney without the pelvic urine weighed 50 gm. and the cortex measured only 3 to 5 mm. In addition to marked pyelonephritis with large areas of fibrosis, severe arteriolar sclerosis was noted microscopically.

Besides the suggestive history and the finding of hypertension two years before, frequent recordings over the five immediately preoperative months demonstrated excessive pressure varying from 190/100 to 220/130.

* From the Department of Urology, James Buchanan Brady Foundation of the New York Hospital-Cornell Medical Center, New York, N. Y. The opinions expressed in this article are those of the authors and are not to be considered as reflecting in any way the official views of the Navy Department.

Postoperatively in the hospital tension remained in the vicinity of 130/80. During the first postoperative year there was a decided tendency for the hypertension to reappear with the systolic pressure varying from 130 to 170 and the diastolic from 90 to 110. Three years after operation the blood pressure was 180/110; at nine years, 198/130; and at ten and a half years, 190/104. A graph indicates that: the tension became lower (to 130/80) for several weeks; then rose to a plateau for about six months (130–180/90–108); became increasingly labile (140/90 to 190/120) by the year's end; and finally returned to its former level where it remains ten years later. However, the patient has been completely relieved of his headaches ever since nephrectomy and considers himself in excellent health. Something, presumably the removal of a badly diseased kidney, temporarily lessened the hypertension and permanently relieved the headaches which seemed due to the hypertension. The hypertension was not the principal indication for this nephrectomy.

Case II. R. F. (New York Hospital No. 70963) was a forty-five year old woman with a blood pressure of 160/95. Ten years earlier during an antepartum course a left hydronephrosis with a calculus was discovered. During this sixth pregnancy the patient's vascular tension varied from 130 to 140 systolic and 80 to 96 diastolic. Immediately before delivery the pressure was 164/100 but this promptly dropped and remained at approximately 130/80 during the rest of her hospital stay. Since that time she had had recurrent attacks of left flank pain with chills and fever. Complaints of headaches and dizziness were also noted. One month before admission for nephrectomy the tension was recorded as 150/85, but during the preoperative period this varied from 160 to 180 systolic and 85 to 102 diastolic. Urologic studies demonstrated an infected, hydronephrotic, calculus-containing left kidney with no function by intravenous pyelography up to thirty minutes. Escherichia coli was found in the urine. The right kidney appeared normal. Pathologic study of the left kidney revealed in addition to pus and calculi much active inflammation as well as fibrosis. A surprisingly large amount of parenchyma was commented upon in the pathologist's report.

Two, and again five, months after operation the tension was 120/70. During the next six years there is no blood pressure record, but six years and eight months after nephrectomy blood pressure was 156/88. Intravenous pyelography demonstrated an apparently normal-remaining kidney five years after operation. Headaches had subsided. Unfortunately this record is incomplete but the tension did return to normal for at least five months after operation, and at six years later it is still at or below the lowest observation made during the patient's preoperative stay in the hospital. The indication for nephrectomy was not hypertension, however.

Case III. E. S. (New York Hospital No. 300736) was a forty-eight year old woman whose blood pressure was 180/120. Her brother had died at forty-nine years with hypertension and her mother died at forty-seven years with cardiac disease. The patient complained of almost constant headaches for two months and of frequency for one month. Six weeks previous to hospital admission the family physician discovered hypertension and nineteen days before the pressure in the right arm was 178/128 and in the right leg 222/150. Although physical examination and radiography demonstrated tortuosity of the aorta and suggested left ventricular enlargement, the electrocardiogram was normal. Tortuosity of the vessels and arteriovenous nicking were seen in the ocular fundi. Urologic studies revealed a normal right kidney which concentrated urea to 16 gm./L. and excreted 11 per cent of phenolsulphonphthalein in ten minutes after a five and a half minute delay following injection of 1 cc. Simultaneously the left kidney did not function by intravenous pyelography up to one hour, concentrated urea to only 2 gm./L. and excreted 5 per cent of phenolsulphonphthalein in ten minutes, after a four and one-half minute delay. The pyuria, which came from the left kidney, contained acid-fast bacilli. Pathologic examination of the left kidney disclosed calcification, caseation and other marked evidences of tuberculosis.

During the eighteen preoperative days in the hospital the blood pressure ranged from 150/90 to 180/120 with an average of 174/106. During the fifteen postoperative days the systolic pressure never reached 150 and the diastolic varied from 78 to 100, averaging about 85. Four, five, and eight months later

the tensions were recorded as 145/85, 135/98 and 140/100, respectively. Several observations made almost four years after operation were in essence 160/112; but after periods of five years and ten months, and nine years and ten months the blood pressure was 150/100 and 150/90, respectively. The patient has been relieved of headaches and urinary symptoms. The speculation is that an improvement did occur because the hypertension did not progress and, in fact, seems lower even ten years after nephrectomy. The kidney was removed for tuberculosis, not for hypertension.

Case IV. I. M. (New York Hospital No. 293443) was a twenty-five year old woman with a letter from a physician stating, "For the past three years patient is suffering from hypertension of a malignant type, ranging between 235 to 165/128 to 108." Four years earlier during her third pregnancy the blood pressure and urinalysis were said to have been normal. An elevated systolic pressure (170) was first noted three years earlier during examination for incapacitating daily headaches. For the preceding one year she had limited activity because of dyspnea on exertion, blurring of vision, occasional ankle edema, precordial pain and the continuing headaches. The ocular fundi revealed marked spastic changes in the arteries and arteriovenous nicking but no exudates. The electrocardiogram gave evidence of myocardial damage but the heart was not demonstrably enlarged. Pyuria with E. coli was found. The blood urea nitrogen was 8 mg. per cent and the urea clearance was 107.4 per cent and 119.4 per cent of normal. Phenolsulphonphthalein output was 95 per cent in two hours. Urine could be concentrated to 1.018 and diluted to 1.003. Urologic studies demonstrated a normal left kidney but the right was dilated above an area of constriction in the ureter 3 cm. below the ureteropelvic junction. The left or good kidney concentrated urea to 1 gm./L., excreted 24 per cent of phenolsulphonphthalein in ten minutes after a two minute delay, and had clear urine. Simultaneously, the right or diseased kidney concentrated urea to ¼ gm./L., excreted 5 per cent of phenolsulphonphthalein in ten minutes after a three minute delay, and had urine loaded with bacilli but surprisingly with only a few pus cells. The removed kidney was knobby and small, measuring 8 by 5.5 by 3 cm. In addition to the dilation a marked pyelitis was present. The cells of the tubules were swollen and many were degenerated. The glomeruli were fairly well preserved but the arterioles entering them, as well as other vessels, had thickened walls. The pathologist's diagnosis by microscopy was nephrosclerosis and subacute pyelitis.

During two weeks of preoperative observation in the hospital, only one recording of the blood pressure was less than 150/100 (i.e., 132/96). The average of fourteen daily recordings was 158/111. The systolic readings varied from 132 to 210 and the diastolic from 96 to 130. Although a tension of 130/82 was noted on the first postoperative day, no consistent trend was evident until after the first week. A febrile reaction to a wound infection occurred. During the last forty-five days in the hospital her blood pressure varied from 110 to 130 systolic, and from 65 to 100 diastolic; the highest was 130/100 on one occasion. Two months and three months later the tension was 165/105. Ten months later her physician reported pressures of 152/108 and 145/105, and two years postoperatively, as 180/95. This same physician, who knew our interest in the case, reported her blood pressure as only 135/80 three years and five months after nephrectomy. During the third to sixth years, inclusive, the tension remained within normal limits. Seven years after nephrectomy her obstetrician wrote that the patient "had a perfectly uncomplicated pregnancy." She was relieved of symptoms almost from the time of nephrectomy. A cure of hypertension has occurred—if three years of normotension and relief of symptoms is sufficient measure. Interestingly the tension became normal promptly, but then rose (not to the previous highs, however) and remained elevated for over two years before restitution to normal. A brief follow-up would not have detected this outcome. The nephrectomy was done largely because of the hypertension.

Case V.* M. K. (New York Hospital No. 125089) was an eight and one-half year old girl with a blood pressure of 220/180. Because of suspected rheumatic cardiac disease, which her mother and five siblings had, this patient had been followed for four years. Three and one-third years earlier her tension was 90/70 but

*This case is referred to by Dr. Homer Smith[1] as the case of Drew.

twenty-one months before admission to the hospital the recording was 180/130. Twenty months prior to admission the pressure was 150/120 but with rest it fell to 120/70. During the month before nephrectomy the blood pressure varied from 170/120 to 220/180, averaging 196/149. The tension in the left leg was recorded as 225/180. Frontal headaches with nausea and vertigo had been frequent for two months. The ocular fundi and heart appeared normal. Routine laboratory tests, including an electrocardiogram, were normal except for occasional albuminuria to as high as two plus. The urine could be concentrated to a specific gravity of 1.026, and the phenolsulphonphthalein output was 100 per cent in two hours. Repeated determinations of blood urea nitrogen were normal. A not entirely satisfactory urea clearance test revealed 64 per cent and 109 per cent of normal. The basal metabolic rate on two occasions was +24 per cent and +12 per cent. Urologic studies indicated a normal left kidney which concentrated urea to 8 gm./L. and excreted phenolsulphonphthalein three and a half minutes after intravenous injection, while the right kidney simultaneously excreted so little that neither test was possible. Function on the left was good by intravenous pyelography but function was almost absent on the right. Retrograde pyelography demonstrated a tiny right kidney with miniature and irregular calyces.

The right kidney measured 4.5 by 3.0 by 1.5 cm. and weighed only 7.5 gm. Microscopically evidences of chronic pyelonephritis with broad areas of fibrosis were noted. Marked arteriolar sclerosis and glomerular fibrosis were conspicuous.

During the first ten postoperative days the blood pressure fluctuated markedly but seemed generally lower. After these first ten days the tension varied from 120/60 to 129/90, averaging 125/86 during the last thirteen days in the hospital. The frequency and degree of albuminuria diminished promptly and urinalyses over the ensuing ten years have usually been normal. During the first year after discharge the pressure varied from 110/70 to 128/84 (six recordings) but at seventeen months and eighteen months it was 140/90, 120/90, 130/80 and 130/88. During observation in the hospital at this time the pressures were 130/80 to 90 in bed and 115 to 130/75 to 80 while up; the average of three phenolsulphonphthalein tests was 65 per cent in two hours; the highest specific gravity of the urine was 1.027; intravenous pyelography appeared normal on the left; and the urea clearance was 62 per cent of normal. The apparently hypertensive headaches disappeared. Over the ten years since nephrectomy the patient has visited the hospital many times with hysteria, dysmenorrhea and nausea with vomiting. Hospitalization was necessary on two occasions of pernicious vomiting. During these two admissions the highest pressures were recorded: 165/90 and 170/90. Other than these two isolated instances the highest blood pressure has been 135/88. The average of thirty-six consecutive records during these ten years was 125/76. Nine years and ten months after nephrectomy the tension was 110/60. It seems evident that a "cure" of hypertension has been obtained. The principal indication for nephrectomy was the hypertension.

COMMENTS

This experience is in contrast to the 34.3 per cent of favorable results reported recently by Puppel and Alyea.[2] In their group classified as severe, favorable results were obtained in only 15 per cent, however. We have required evidence of a persistently and clearly elevated blood pressure prior to operation before classification as hypertensive, while approximately one-third of their cases are labeled as mild. Furthermore, our criteria for improvement have been strict and perhaps too high. For example, we have demanded evidence of normotension throughout a two year period (and symptomatic relief) as indication of excellent outcome, whereas one normal recording at some date two or more years after operation seems accepted by Puppel and Alyea.[2] It is conceivable that some normal recordings might be obtained two years later even when no actual change in the mild (labile) state had occurred. The possibility exists that we have failed to detect some favorable results in our series because, as can be noted in Case IV, the situation two years later is not an infallible measure of success or failure. The removal of the more recent cases from our series would increase the percentage of favorable findings. Generally speaking, our selection would appear to correspond largely with their group of severe cases and our defini-

tion of a favorable result seems more exacting. Actually, therefore, our findings and those of Puppel and Alyea are probably not so divergent as they first appear.

The propriety of using the term "results," connoting a cause and effect relationship, may be questioned. Some of the "results," ours included, could be occurrences due to factors other than the nephrectomy. The work of Goldblatt[3,4] and many others[5–10] provides a basis upon which to believe that nephrectomy has been *the* factor, yet absolute proof in the individual case is not easily obtained. In Case IV the cure did not definitely appear until two years after the nephrectomy, whereas in Case V a favorable outcome was immediately evident. Whether this means that the cure in Case V was due to the nephrectomy and that in Case IV was due to other unrecognized factors is not known; but in the light of present knowledge and common usage we assume that nephrectomy has been the causative factor in both. In Case I a long-standing hypertension was reduced for several months after nephrectomy but this effect has been noted many times following seemingly non-specific operations. Even the permanent symptomatic relief in this case is difficult to attribute positively to the absence of the diseased renal parenchyma, although we think so. In Case II the blood pressure has been significantly reduced from its highest levels but a suspicion exists that the tension was labile originally and it may still be so. In Case III a similar situation obtains. When the tension does not increase after operation, it is tempting to consider that at least progress has been halted, especially if some symptomatic improvement occurs. A check on such speculation is the realization that the natural course of the hypertensive disorder varies among patients and even in the same patient, and is often affected by a variety of situations and therapies.

This review provides no reason to change our conservative policy of only rarely performing nephrectomy for the sole or even principal indication of hypertension. The incidence of marked success has been low, i.e., 6 per cent. The development of better diagnostic-prognostic tests might well provide more candidates. In the cases showing improvement the renal disorder was clearly unilateral and especially it was so marked as to be a good indication for nephrectomy even if hypertension had not existed.

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A NEW METHOD OF ESTIMATING BLOOD LOSS DURING SURGERY

FRANK COLE, M.D.
Lincoln, Nebraska

IT is not always easy to determine how much blood a patient has lost during surgery. Methods of estimating loss and guides to replacement include these: (1) Aspirating blood from the operative field into a graduated container; (2) weighing sponges (1 cc. of blood is more than 1 gm., by 5 per cent); (3) directing lost blood into a solution whose volume and color index can be measured; (4) weighing the patient; (5) using blood loss figures established as average for various operations; (6) observing the operating field, gowns, floor and sponges; (7) watching blood pressure, pulse rate and respiratory rate; (8) blood cell count, hemoglobin and blood volume determinations; (9) duration of surgery.

In emergencies it is sometimes difficult to decide how much blood a patient should be given, and to know when to stop transfusing. Colorimetric estimations are made infrequently and generally only at the end of an operation. Waiting for the blood pressure to fall or for the pulse rate to rise means replacing the blood "too little and too late." The technic of weighing sponges introduces the disadvantage caused by allowing bloody sponges to accumulate and announcing that the loss has suddenly increased by 1,500 cc. Determining the loss colorimetrically and weighing sponges requires practice and equipment. Other methods, including laboratory tests, are impractical for minute to minute control of the patient.

The anesthesiologist should at all times know the amount of blood that has been lost. It is his duty to replace it as accurately and as rapidly as it is being lost. Figure 1 shows how this can be done and represents a study of a gastric resection in which more than the usual amount of blood was lost. It is not at all good merely finishing an operation with identical blood loss and replacement. Loss and replacement must run parallel courses; falling behind the blood loss by 1,000 cc. or more and catching up an hour or two later will produce a blood replacement record that does not tell what really happened and may cause irreversible shock. Blood must be replaced when it is lost, not later when the bleeding has stopped.

A new method is offered which will enable the observer to determine the blood loss within seconds with a fair degree of accuracy, without any equipment, at any time during the operation and by simple inspection. The blood is always found either in a suction bottle or on sponges. The sponges are put in pails (if they are not counted) or on racks (if they are counted). The entire blood loss equals the sum of (1) what is in the bottle, (2) what is on the sponges and (3) what is in the field. The suction bottle can be graduated with adhesive strips, after measured volumes of water are put in the bottle, as is shown in Figure 2. Allowance must be made for any liquid that is poured into the field and aspirated into the bottle. This can be done by observing the bottle before and after irrigation of the operative site or by using known volumes of irrigating fluids. In major cases, and these are the only ones that present the blood loss problem, about 300 cc. can be assumed to be constantly present in the operating field. The blood content of sponges and of pails and sponge racks were measured in this study.

Sponges used in surgery include (1) small "rosebuds"; (2) "rosebuds," or tonsil sponges; (3) four-by-fours; (4) four-by-eights; (5) abdominal packs, four-by-eighteens ("tapes"); and (6) "laps," or abdominal packs, eighteen-by-eighteens. The most commonly used of these are the four-by-eights and laps.

A 3 gallon pail was used in actual surgery and in measuring known blood volumes in simulated operating room conditions; it was 11 inches across the top, had a bottom diameter of 8½ inches and stood 9 inches high.

Five hundred cc. of overage citrated whole blood were contained in sixty-six four-by-eights made to resemble bloody sponges found after actual surgery. These filled about half a pail. Each four-by-eight thus contained nearly 8 cc. of blood while a pailful of these sponges would contain 1,000 cc. of blood.

One hundred cc. of blood were soaked up in

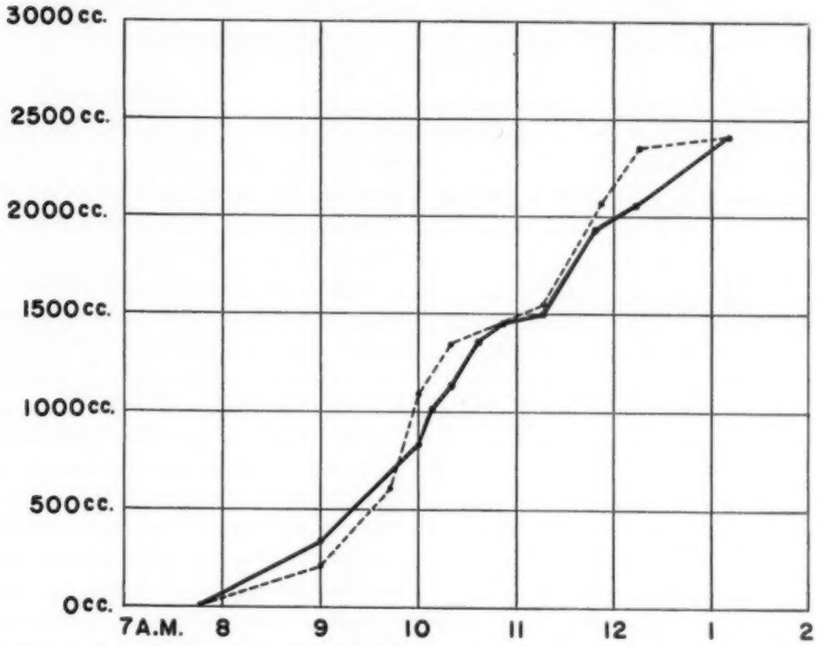


FIG. 1. Repeated estimations of blood loss and blood replacement during a case of gastric resection. Broken line indicates blood lost. Solid line indicates blood replaced.

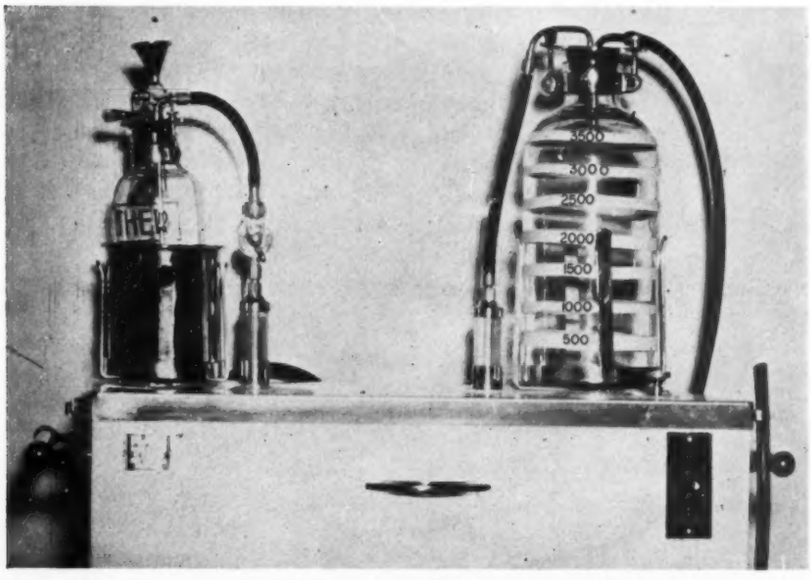


FIG. 2. Transparent suction jar graduated with strips of adhesive tape to show, at a glance, the exact amount of blood removed by aspiration.

thirty-two rosebuds; each therefore held about 3 cc.

Abdominal packs were wet and wrung dry, as is the custom during surgery. It was found that 200 cc. of blood were held by nine such sponges so that each contained about 22 cc.

Four-by-fours were similarly tested; all tests were then repeated when an attempt was made to saturate the sponges.

After an actual operation a pail was found to be about seven-tenths filled with bloody sponges whose blood content seemed average. The contents of the pail were: eighty-one four-by-eights, two laps, and twelve four-by-fours.

The predicted content would be about 700 cc. which agrees with the previous estimation of 1,000 cc. per pail.

A rackful of four-by-eights (six rows of ten each equals sixty sponges, or 480 cc.) is the equivalent of 1 pint of blood. The blood contents of sponges, pails and racks are shown in Table 1.

TABLE 1
BLOOD CONTENT OF SPONGES, PAILS AND RACKS

	Average (cc.)	Saturated (cc.)
Small rosebud	1	2
Rosebud	3	10
Four-by-fours	4	11
Four-by-eights	8	23
Four-by-eighteen	15	33
Lap (eighteen-by-eighteen)	22	100
Rack	500	—
Single row of 10 sponges	100	—
Pail	1,000	—

The figures in the first column of Table 1, marked "average" are almost invariably to be applied. The second column shows how high the blood content of saturated sponges can be, and may be used in very unusual cases. Column 1 should be employed in practically all cases; a glance at the sponge rack will immediately tell the anesthesiologist if the sponges are exceptionally bloody. Beware of the saturated "lap"; it may require only five of them for one transfusion.

CONCLUSIONS

A new method is offered for determining blood loss during surgery. The amount of blood lost can be estimated by adding what appears in the operating field, what is seen in the suction bottle (the bottle should be graduated) and the sponge content. Estimation can be done easily, quickly and accurately and should be done repeatedly during surgery and at the end of every operation. The quantity of blood that has been lost should be known at all times; replacement must never be allowed to fall significantly behind the loss at any time during an operation. In many bloody operations nearly the entire blood loss is contained in the discarded sponges and little or none will be seen in the field or in the bottle. To estimate the amount of blood that is contained in the discarded sponges, allow 3 cc. for each rosebud, 8 cc. for each four-by-eight, 22 cc. for each "lap"; allow 500 cc. for a rackful of sponges or about 100 cc. for each row. If the sponges are not being counted, assign a value of 1,000 cc. for a pailful of bloody sponges. For saturated sponges these figures may be increased but the amounts given above may be used in the vast majority of cases. Where sponges are fastened individually to a rack in rows of ten, the loss can be determined at a glance.

RHINOPLASTY

PSYCHOGENIC ADJUNCT IN THE TREATMENT OF VASOMOTOR RHINITIS

LESTER W. EISENSTODT, M.D.

Newark, New Jersey

VASOMOTOR rhinitis may be defined as an exaggerated hypersensitivity of the mucous membrane of the nose. Once it has developed it is more or less permanent. Two main types are usually described: (1) hay fever or the recurrent seasonal type of allergy due to known specific pollens and (2) the perennial type, more complex and due to many and often unknown allergens. In many cases emotional, neurogenic and psychogenic factors have been found to play a definite role in the etiology of vasomotor rhinitis. A hereditary tendency is usually found as many cases often occur in the same family. It is the purpose of this article to discuss the results of the surgical treatment of vasomotor rhinitis in over 500 cases seen during the past ten years.

In vasomotor rhinitis the nasal mucous membrane does not expand and contract readily as in the normal nose. Instead it is constantly edematous and results in almost continuous nasal obstruction. The mucous membrane of the turbinates is frequently found to be pale and boggy, and the inferior and middle turbinates are most often involved. The hypertrophy of the anterior tips of the inferior turbinates is most often the cause of the nasal obstruction. The typical, classical, severe type of nasal allergy shows the mucous membrane of the nose to be quite pale. However, it is variable and may be colorless or show any tint from a very light pink to a bright red color. The color could be normal even though an allergy was present, or bright red if an inflammation was superimposed on an existing allergy.

The edema of the turbinates is due to a relaxation of the erectile tissue and subsequent dilation and engorgement of the capillaries and peripheral vessels. Increased capillary permeability occurs, with a resulting profuse watery discharge. If inflammation occurs, the discharge becomes thicker and more mucoid in character.

The patients suffer from recurrent, severe, paroxysmal bouts of sneezing due to their hypersensitivity. One can usually elicit an attack by merely touching the nasal septum or turbinate with an examining probe. In these individuals the slightest exposure to drafts, which most people tolorate, can cause reflex dilation of the vessels of the turbinates, with subsequent nasal edema, profuse rhinorrhea and sneezing.

Most patients complain of difficulty or inability to breathe through the nose, with the difficulty becoming worse at night. The nasal obstruction is usually bilateral and constant. Occasionally it is unilateral and alternating. The patients have a "nasal twang" to their voices and complain of headaches and lassitude. Photophobia, epiphora and injection of the eyes may or may not be present. The columella, alae and upper lip sometimes itch and may be inflamed due to the nasal discharge and irritation caused by repeated wipings. The acuity of the sense of smell is usually diminished and may be lost.

In recent times more physicians have emphasized the importance of psychogenic factors[1–5] in vasomotor rhinitis. Wolf et al.[6] said, "Of late there is gathering evidence that even symbolic noxae, that is words or events which threaten the security of the individual by reason of earlier conditioning experiences may initiate pathophysiologic reactions and lead to structural organic disease." Today patients with nasal deformities are no longer looked upon cynically when they desire nasal correction. One now realizes that the mental anguish of these patients may be so great as to cause a complete disruption of the patient socially. Thoughtless ridicule by unthinking people can aggravate this maladjustment. The ridicule can develop a "facial contour neurosis" in this type of patient which, although usually only a minor mental malady, can result in complete derangement of the individual. These patients may be cured by

the surgical correction of the nasal deformity. However, one attempts to differentiate them from the "facial contour psychotic" who cannot be cured by surgery but will merely shift his complaints to another organ.

TREATMENT

The majority of otolaryngologists and allergists treat vasomotor rhinitis through desensitization by injections after skin testing. In some cases antihistaminics and vasoconstricting nose drops are efficaceous. However, the beneficial effects of this treatment are merely palliative and the symptoms return upon cessation of treatment. At present surgery appears to be the only method of therapy which can offer hope for more than palliative relief. The technic aims toward more or less permanent desensitization in addition to obtaining normal ventilation by surgically clearing the nasal passages.

At the turn of the century otolaryngologists sacrificed turbinates indiscriminately. In the early twenties the pendulum swung in the opposite direction toward ultraconservatism which still prevails today. In postgraduate teaching one is prevailed upon not to sacrifice turbinates but merely to diminish their size. Some perform this by submucous electrocoagulation and others through surface destruction of the mucous membrane by means of the electric current or repeated applications of chromic acid or trichloroacetic acid. Zinc ionization is another method which some men prefer. All of these technics are useful in helping to obtain wider and clearer nasal passages besides desensitizing the nose for short periods of time.

The results obtained by employing these accepted methods of treating vasomotor rhinitis were never completely satisfactory. After appraising my results and comparing them with those obtained by other otolaryngologists, allergists and men trained both in allergy and otolaryngology, I believed that the current methods of treatment still fell far short of desired end results. Treatments were at best palliative. A considerable number of clinic allergy charts were studied. Many were found to be larger than big city telephone directories. Upon questioning it was found that these patients remained controlled and comfortable so long as they received weekly or biweekly injections. Their symptoms and discomfort returned shortly after discontinuing treatment.

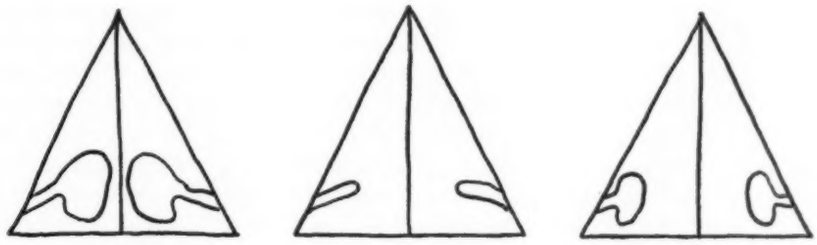
With the spectacular growth, increased popularity and acceptance by the medical profession of rhinoplastic surgery, many patients with vasomotor rhinitis and a nasal deformity sought plastic correction of their nasal physical deformities. In the early forties they were refused rhinoplastic surgery because it was thought that the narrowing of the nose and nasal tip would diminish nasal ventilation and tend to aggravate the nasal allergy. After refusing rhinoplastic surgery to these individuals it was found that they were operated upon by other surgeons. The patients returned several months later seeking relief because the rhinoplasty had intensified their nasal obstruction. Upon examination it was found that rhinoplasty had been performed without submucous resection and that the turbinates were still hypertrophied and obstructive. It was then decided that rhinoplasty would not be denied, but that it would be performed concomitantly with a submucous resection. In addition the turbinates would be reduced in size postoperatively by office treatments. This was performed with satisfactory results but the patients objected to the discomfort of many office treatments. The operative procedure was then augmented to include partial amputation of the tips of the inferior turbinates with the submucous resection and rhinoplasty. The middle turbinates were rarely sacrificed but were outfractured to improve nasal ventilation whenever it was deemed necessary. The operative results were almost uniformly satisfactory and were found to be preferable to the other methods of treatment.

Ninety per cent of the patients treated in this manner were greatly improved. Many have been symptomless for periods as long as nine years and may be assumed to be cured. As a possible explanation of these results one must bear in mind the great part that emotional, neurogenic and psychogenic factors play in allergy. It may be said that "patients who look better feel better." Walsh[7] stated, "There is ample evidence to support the concept that a sympathetic-parasympathetic imbalance is the mechanism causing vasomotor rhinitis." Psychogenic factors play a much greater part in vasomotor rhinitis than has heretofore been attributed. The individual who is self-conscious of his nasal deformity

must be rehabilitated before normal nasal function can be established.

There is a considerable amount of nasal surgical trauma in rhinoplasty. This causes a sufficient amount of shock to act as a non-specific desensitizer of the nose and nasal mucous membranes. The submucous resection and bilateral partial amputation of the tips of the inferior turbinates will clear any obstruction in the nasal passages. The results of submucous resection, rhinoplasty and bilateral partial inferior turbinectomy in over 150 cases have been very satisfactory and at times spectacular. It is axiomatic among otolaryngologists not to operate during the allergic season when patients are suffering the most from sneezing and profuse rhinorrhea. This is followed by most otolaryngologists, and surgery is not performed unless it is imperative. It has been my practice for the past ten years to perform operations at this time. In fact it is my contention that this is the ideal time for vasomotor surgery. These operations have been performed with no untoward results. The multiple severe paroxysms of sneezing and watery nasal discharge with photophobia and lacrimation either disappear or diminish immediately after surgery. Approximately 10 per cent of the patients treated by this technic were not aided functionally and their symptoms continued unabated.

Postoperative follow-up examinations of these patients for periods as long as nine years have shown that the interiors of the noses remain clear and healthy. An interesting observation has been found in many cases. That portion of the inferior turbinates which was not altered by surgery was found to undergo compensatory allergic hypertrophy. (Fig. 1.) The mucous membrane swelled superiorly and inferiorly. It was prevented from enlarging medially since the medial aspect of the turbinates was excised and this area was replaced by scar epithelium. The hypertrophy of the remaining mucous membrane of the turbinates allowed the turbinates to carry out their normal respiratory functions and at the same time permitted clear non-obstructive nasal ventilation.



1A 1B 1C

FIG. 1. Bilateral allergic hypertrophy of the inferior turbinates; B, bilateral partial amputation of the tips of the inferior turbinates; C, compensatory allergic hypertrophy of mucous membrane of remains of tips of inferior turbinates permitting satisfactory nasal ventilation without crusting or dryness.

Accurate statistics of the degree of improvement or percentage of cures in patients operated upon using submucous resection, rhinoplasty and resection of the tips of the inferior turbinates for vasomotor rhinitis cannot be established. The amount of improvement can be ascertained only by questioning the patient. Every patient is followed up postoperatively for at least six months but only a few return for periodic examinations after that time. The results of surgery in almost all cases for the first six months are good or excellent. Those few patients who return yearly for examination have shown that cures can be achieved for periods as long as nine years after operation. Some patients are still free of all symptoms.

Polyps were found in only a small percentage of patients, who sought rhinoplasty because of vasomotor rhinitis. When present these polyps complicated the procedure. In most instances large single or a few massive polyps which completely blocked the nasal passages were seen. Only a few patients had multiple small polyps. These were usually found originating from the middle meatus. The polyps were excised simultaneously with partial amputation of the tips of the inferior turbinates, submucous resection and rhinoplasty. When only single large polyps were extirpated, the results obtained were excellent.

Poor results occurred when multiple small polyps were extricated as the polyps recurred most of the time. On many occasions the inferior turbinates were found to have undergone allergic polypoid degeneration and these were easily eradicated in the usual manner.

RESULTS OF VARIOUS SURGICAL PROCEDURES IN VASOMOTOR RHINITIS

Bilateral Partial Inferior Turbinectomy. This procedure was performed when the inferior turbinates were hypertrophied, turgescent and obstructive. They are more or less useless as they do not contract and expand as do the normal turbinates. The results of this procedure were beneficial in that nasal ventilation was improved but the sneezing and other allergic symptoms continued. Crusting or dryness did not occur.

Submucous Resection. This procedure was performed when the nasal septum was wide, thick or deviated causing nasal obstruction. The operation improved nasal ventilation and diminished somewhat the discomfort of nasal obstruction, but the symptomatology of vasomotor rhinitis continued.

Submucous Resection and Bilateral Partial Amputation of the Tips of the Inferior Turbinates. A combination of these procedures gave good immediate results. The nasal passages were cleared and the allergic symptoms were diminished or alleviated. However, the procedure gave only temporary allergic relief as the vasomotor symptoms recurred after approximately three months.

Submucous Resection, Rhinoplasty and Bilateral Partial Amputation of the Tips of the Inferior Turbinates. These procedures performed concomitantly gave the best results. Occasionally it was also necessary to excise polyps, partially amputate the middle turbinates or outfracture them, exenterate the ethmoids or reposition the septum in the midline. In previous articles on rhinoplasty[8–10] the beneficial results of a combination of these procedures in vasomotor rhinitis were noted. The vast majority of patients showed considerable improvement and many have been completely free of symptoms for periods as long as nine years. No patients suffered more from their allergy as a result of this operation.

COMMENTS

Vasomotor rhinitis has been successfully treated by a combination of operative procedures performed simultaneously, namely, submucous resection, rhinoplasty and bilateral partial amputation of the tips of both inferior turbinates. The results of this operation have been most gratifying in over 150 cases. The greater proportion of these operations were performed during the height of the allergy season when the patient's symptoms were the most severe. The vast majority of these patients had been skin-tested and had received allergic therapy for many years. Patients were accepted for operation merely on the basis of their nasal deformities and no attempt was made to determine their type or degree of sensitivity. The operations were performed with complete disregard for the type of allergen except for drugs or chemicals which were to be used in the surgical procedure. The patients' ages ranged from twelve to sixty-five years. They were found to have excellent recuperative powers and made rapid recoveries. No serious complications or untoward reactions occurred. In two cases mild vesicular dermatitis developed with angioneurotic edema of the face from adhesive tape, but these resolved normally. The favorable results obtained by this combination of procedures may be hypothesized on a twofold basis: (1) the psychogenic factor of "patients who look better feel better" and (2) the non-specific desensitization of the nose and mucous membranes by the extensiveness of the operation.

In over 350 intranasal operations, submucous resections, partial amputation of the tips of the inferior turbinates or both in vasomotor cases, the beneficial results attained were only temporary. In most instances the nasal passages were cleared but the vasomotor symptoms recurred. If rhinoplasty was performed *pari passu* with submucous resection and bilateral partial amputation of the tips of the inferior turbinates, the results were more beneficial and of a more permanent nature. Virtually all of the patients were improved. One may therefore conclude that the efficacy of the operation depends upon the beneficial psychogenic factor in rhinoplasty in addition to the non-specific desensitization caused by the more extensive operation.

The rhinoplastic operations were performed mainly for esthetic improvement. In the course of the operation any intranasal obstruction was corrected. The gratifying allergic improvement was incidentally discovered. The paroxysms of sneezing diminished almost

immediately after operation but the improved nasal ventilation was not evident for at least three weeks postoperatively. At this time the surgical edema had subsided and the crusts on the raw surfaces of the turbinates had separated.

This treatment is advocated only for those patients having a nasal deformity and vasomotor rhinitis. It is not suitable for every case of nasal allergy. It is particularly effective in those allergic individuals possessing a nasal deformity with the desire for cosmetic improvement. The nasal deformity is a necessary prelude for treatment and the beneficial results that ensue.

CONCLUSIONS

1. A "facial contour neurosis" can develop in patients with a nasal deformity who are subjected to repeated, thoughtless ridicule.

2. The best surgical results in the treatment of vasomotor rhinitis were attained by the simultaneous performance of rhinoplasty, submucous resection and bilateral amputation of the tips of the inferior turbinates during the height of the allergy season. This operation was performed in over 150 cases with complete disregard for the severity or type of allergy, with no untoward results.

3. "Patients who look better feel better." This is probably the essential psychogenic factor responsible for the beneficial effects of the aforementioned operation. The nasal shock caused by the extensiveness of this procedure may well act as a non-specific desensitizer of the nose and nasal mucous membranes and thus enhance the results.

SUMMARY

As a result of this study one might postulate that vasomotor rhinitis may be caused by psychogenic factors on a possible genetic background coupled with a sensitivity to external allergens. The results are reported merely to stimulate interest for possible further investigations along these lines. It is possible that more emphasis should be placed upon psychogenic factors both in the etiology and therapy of vasomotor rhinitis. Psychotherapy may well prove to be a valuable adjunct for the effective treatment of vasomotor rhinitis.

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NEUROSURGICAL PROCEDURES FOR RELIEF OF INTRACTABLE PAIN

SIDNEY W. GROSS, M.D.

New York, New York

THE anatomy of the pathways for pain is now well known and surgical methods for interrupting them are no longer in the experimental stage; yet many sufferers are enslaved by severe intractable pain, often of unknown cause or due to inoperable malignancy. Most of the procedures about to be described have had extensive clinical trial and the indications for their use have become more or less standardized. The problem of face pain is a chapter in itself, and will not be considered at this time.

Peripheral Nerve Section. This method has limited application. It is of greatest value for relief of severe pain in the lower extremities due to peripheral vascular disease, especially thromboangiitis obliterans. In order to accomplish the desired result in a patient with ulceration or gangrene of the toes or feet, it is necessary to interrupt the posterior tibial, deep and superficial peroneal, and the sural nerves. This must be done in stages by careful anatomic exposure of the nerves in the leg with the least trauma possible. Each nerve is either crushed or preferably sectioned and resutured. The sensory and sympathetic branches as well as the motor nerves supplying the intrinsic muscles are divided. Paralysis of the small muscles of the foot causes only slight disability in walking, while interruption of the sensory nerves does away with pain. The sympathetic paralysis results in a local suppression of vasospasm. As a rule ulcers heal, gangrenous parts become clearly demarcated and slough, while pain relief in favorable cases is complete.

Division of the obturator nerve for persistent hip pain, and of the sural and posterior tibial nerves for painful heel, has been reported. These procedures have had sufficient trial to permit proper evaluation at this time. Kaplan noted "general improvement" in 67 per cent, and "good results" in about one-third of fifty-four patients who had had avulsion of the obturator nerve for painful hip joints.

Rhizotomy. Interruption of afferent pathways by division of sensory (posterior) spinal nerve roots theoretically would seem to be an ideal method for the relief of localized pain. However, in practice the results are often disappointing. Postherpetic neuralgia and the symptoms of the phantom limb syndrome following amputations are rarely influenced by posterior root section. Nevertheless the method has definite value in selected cases. Our knowledge of the segmental distribution of the sensory nerve roots in man is the result of long years of careful observations of numerous investigators. Foerster of Breslau made many of the fundamental contributions in this field. Posterior root section is most useful for the relief of pain in the neck, shoulder girdle, upper chest and upper extremity. Pulmonary sulcus tumors and other malignant tumors which invade the nerve roots and the brachial plexus are commonly accompanied with agonizing pain. Cordotomy may not be effective in these cases. Extensive posterior root section (C_5 to T_3) is often followed by relief of pain. The most serious objection to posterior rhizotomy for pain in the upper extremity is that it results in a deafferentation of the limb. However, in many patients there is usually much pre-existing disability due either to involvement of motor roots or to limitation of motion by pain. In one of my patients with extensive infiltration of the brachial plexus due to Hodgkin's disease complete relief of pain followed section of C_5 to T_3 sensory roots.

Posterior rhizotomy is useful in the control of pain of traumatic nerve root lesions following fractures and gunshot wounds of the spine. The pain of angina pectoris can be controlled by bilateral section of the posterior spinal roots from T_1 to T_5. This method has thus far had only limited application and there are some valid objections to its use. Nevertheless in selected cases the results have been most gratifying. It is especially indicated when precordial

distress is accompanied with pain radiation into both upper extremities. Section of the upper three cervical posterior roots (C2, 3 and 4) is usually combined with division of trigeminal and glossopharyngeal nerves for unbearable pain due to inoperable carcinoma of the buccal cavity and nasopharynx.

Cordotomy. It has been known for some time that the pain fibers in the spinal cord travel in the anterolateral column. However, it was not until 1911 that the anterolateral tracts were deliberately sectioned for the relief of pain. Since then our knowledge of spinal cord physiology has increased and many cordotomies have been done for intractable pain. Section of the spinothalamic tract in the spinal cord is most useful for intractable pain in the lower abdomen, pelvis and lower extremities. The upper thoracic cord is the usual site for cordotomy for the relief of pain below the umbilicus. The section in the spinal cord should be made precisely at the attachment of the dentate ligament. Although there have been some reports of section of the spinothalamic tract in the high cervical region for pain in the upper extremities, the results of this operation are often disappointing. Bilateral high cervical cordotomy carries with it some risk, since edema of the spinal cord following section of the spinothalamic tracts might result in respiratory failure.

Hyndman and Jarvis have reported relief in gastric crises of tabes dorsalis by section of the spinothalamic tracts at the second thoracic segment. Retention of urine occurs in more than one-half of the patients who have had bilateral spinothalamic tract sections. This usually improves after a few weeks. Persistent pain after cordotomy may signify that section of the spinothalamic tract was not carried deep enough or far enough anteriorly. The technical considerations concerning cordotomy have been discussed by Peet and Kahn, Stookey, Foerster and others.

Sympathectomy. The role of sympathectomy in the relief of intractable pain of vascular or visceral origin is gradually becoming clarified. In most instances the temporary abolition of sympathetic function by paravertebral block makes it possible to predict the result of the proposed sympathectomy. Sympathectomy has proved almost uniformly effective in the treatment of causalgia. This characteristic syndrome of severe, burning, poorly localized pain following peripheral nerve injuries was first described by Mitchell, Morehouse and Keen in 1864. It usually follows incomplete injury of either the median or tibial nerves, though causalgia following injury to other peripheral nerves has been described. Other painful post-traumatic vasomotor disorders and reflex dystrophies apparently of non-traumatic origin are also benefited by sympathectomy. Phantom limb pain is ordinarily not relieved by sympathectomy. Removal of the left upper three thoracic sympathetic ganglia has proved effective in the relief of pain of intractable angina pectoris with radiation to the left upper extremity. For cases of angina with bilateral pain radiation posterior rhizotomy is indicated.

Resection of appropriate sympathetic nerves has proved useful for the relief of unbearable pain associated with some types of visceral diseases, notably chronic pancreatitis, severe dysmenorrhea and pain with vasospastic disorders of the extremities.

Frontal Lobotomy. Psychosurgery for the relief of intractable pain is a method of last resort, to be used only after interruption of the pain conducting pathways has failed to produce the desired result. However, in such cases it is a valuable and humane procedure. Frontal lobotomy abolishes fear and anxiety which accompany unbearable pain; and although some patients continue to complain of pain after lobotomy, the intense emotional reaction to it is absent. In many instances unilateral lobotomy is adequate and blunting or masking of the preoperative personality of the individual is thus reduced. Following lobotomy there is no longer a craving for sedatives or narcotics, appetite improves and most individuals gain weight. In widespread malignant disease with intractable pain, following lobotomy the patient is able to spend his remaining days in relative comfort, no longer craving narcotics and without concern regarding the future. In such cases intellectual impairment and emotional flattening are a small price to pay for freedom from intense anxiety and narcotic addiction. Other procedures have been advocated for the relief of intractable pain. However, such measures as section of the pain tracts in the medulla or mid-brain, resection of the sensory cortex and thalamotomy have not yet had a sufficient trial to permit their proper evaluation at this time.

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MASSIVE hypertrophic gastritis is less often followed by malignancy than polypous gastritis, which it may closely resemble. Since removal of the upper two-thirds of the stomach and anastomosis of esophagus to the distal third suffices for the former but may not be radical enough for the latter, the diagnosis must be "double-checked." Gastric washings for malignant cells, gastroscopic examinations and biopsies, and even surgical exploration are indicated because x-rays often fail to distinguish one disease from the other. Pathologically, massive hypertrophic gastritis is most often seen only in the upper two-thirds of the stomach, whereas polypi occur anywhere. Unfortunately, patients with hypertrophic gastritis present no characteristic clinical symptoms; hence diagnosis is difficult. (*Richard A. Leonardo, M.D.*)

PERIPHERAL NERVE SURGERY

INCISIONS FOR EXPOSURES OF PERIPHERAL NERVES

CLAUDE POLLARD, JR., M.D. AND EVERETT G. GRANTHAM, M.D.

Houston, Texas *Louisville, Kentucky*

THE incisions used for exposure of the major peripheral nerves of the body by various surgeons follow a rather constant general type but the authors have found that certain incisions are somewhat more satisfactory than others. The following descriptions of the incisions to expose the peripheral nerves have been made in order to present the subject in a single article for ease in obtaining one usable method of exposing each of the major peripheral nerves. No originality is claimed for these incisions as slight modifications have been used for many years. It is likewise true that other types of incisions may be used in a satisfactory manner. The ones presented herein are those found most useful by the various operators at the Neurosurgical Center at Tilton General Hospital and Thomas M. England General Hospital during a period of about three years, from 1943 to 1946, during which 1,713 operations on peripheral nerves were performed.

In general the incision that is most useful for exposing a peripheral nerve is one that most closely follows the anatomic course of the nerve. In certain locations, however, it has been found advantageous to curve the incision to reflect overlying structures with minimum harm to them and with maximum speed and avascularity. In addition, incisions that cross the flexor surface of joints are probably better made in a curved or oblique, rather than a longitudinal direction. It is the opinion of the authors that the reluctance of some surgeons to make longitudinal incisions across flexor surfaces has been exaggerated. In most instances these incisions do not produce any significant scar contracture except where a tendency to keloid formation already exists. It is not thought that there is any significant advantage in the S-shaped incision sometimes used in the antecubital and popliteal spaces. Peripheral nerve incisions must be so designed that they may be extensively extended with ease, either proximally or distally, from the site of injury because not infrequently it becomes necessary to make a much longer incision than the preoperative examination has indicated. The most reliable method of being able to extend in either direction is to follow the anatomic course of the nerve as closely as possible.

It has always been the practice of the authors to outline accurately the maximum extent of any incision on the completely exposed extremity before it is covered with sterile drapes. It is only in this way that the anatomic landmarks are accurately seen and palpated and the probable extent of necessary exposure estimated. A thorough knowledge of surface landmarks, muscles and tendons is obviously necessary. It cannot be emphasized too strongly that the misplacing of a skin incision by even 1 or 2 cm. may make the location and exposure of a nerve more difficult, more bloody and more time-consuming than it need be. In addition, it is actually possible to sacrifice a certain amount of nerve length that could otherwise be used to advantage. In no other field of surgery is it more important to incise precisely in the correct site than in exposure of the peripheral nerves. The authors restate what has been said many times, namely, the involved nerve must be generously exposed both proximal and distal to the site of the lesion and the dissection directed toward the injury after normal nerve has been exposed above and below the lesion.

Brachial Plexus. Supraclavicular portion: The portion of the brachial plexus situated above the clavicle may be exposed by one of three incisions. The proper one will depend upon the extent of injury and the degree of exposure desired. The most extensive and satisfactory exposure of the plexus and large vessels is obtained by making a V-shaped incision arising about the level of the thyroid cartilage, extending along the posterior border of the sternomastoid muscle to the region of the sternoclavicular joint and then abruptly

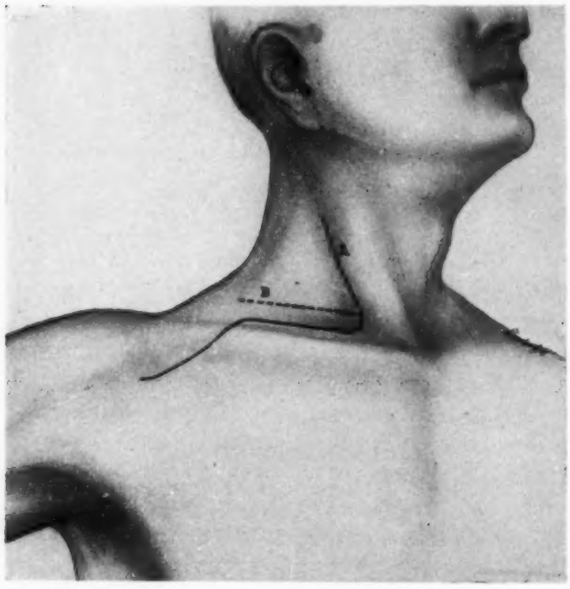

FIG. 1. A, incision for exposure of supraclavicular, clavicular and infraclavicular portions of brachial plexus; B, transverse incision for exposure of supraclavicular portion of brachial plexus. (All illustrations from: GRANTHAM, E. G., ET AL. Peripheral nerve surgery; repair of nerve defects. *Ann. Surg.*, 127: 696, 1948.)

curving laterally along the course of the clavicle to the junction of its middle and lateral one-thirds. (Fig. 1A.) After reflecting the V-shaped skin flap laterally the roots of the plexus and the subclavian vessels may be extensively visualized and the nerves exposed from their bony foramina to their position behind the middle one-third of the clavicle. A second type incision is a transverse one situated about 1.5 cm. above the clavicle, extending parallel to the bone for 5 to 7 cm., centering over the middle of the clavicle. The platysma is divided and the anterior scalene muscle retracted medially or severed if necessary. (Fig. 1B.) A third and least satisfactory incision may be made from the middle of the posterior border of the sternomastoid muscle to the middle of the clavicle. It perhaps has one advantage in that it makes exposure of the region of the foramina somewhat easier.

Clavicular portion: Exposure of the brachial plexus beneath the clavicle may be done in conjunction with a supraclavicular exploration and the incision in such case is an extension of the previously described V incision by curving it obliquely across the middle of the clavicle into the intraclavicular fossa then toward the anterior axillary fold. (Fig. 1A.) About 5 to 7 cm. of the middle one-third of the clavicle is subperiosteally resected with a Gigli saw and rotation of the clavicular fragments will increase the exposure of the nerves and large vessels. The portion of the clavicle which is resected will reform satisfactorily.

Infraclavicular portion: The portion of the brachial plexus extending from the clavicle into the upper arm is exposed by an incision situated over the neurovascular bundle in the upper one-third of the arm which extends proximally in a straight line to the anterior axillary fold where it curves slightly lateral over the insertion of the pectoralis major tendon into the humerus and then in a straight line toward the middle of the clavicle. (Figs. 1A and 3A.) The pectoralis major tendon is detached from its humeral insertion by severing it, and reflection of the pectoralis major muscle medially exposes the neurovascular bundle. If necessary the pectoralis minor insertion may be severed for exposure near the clavicle. Detachment of the pectoralis major insertion makes a more anatomic and less bloody operation and repair of the wound is facilitated. The exposure obtained through the aforementioned incision is adequate for complete exploration of the three cords of the brachial plexus as well as its major branches, such as the axillary portion of the radial nerve and the axillary nerve from the posterior cord, the musculocutaneous nerve and the lateral component of the median nerve from the lateral cord, and the medial component of the median nerve and the ulnar nerve from the medial cord. The radial nerve may be followed distally to the dorsal aspect of the surgical neck of the humerus in the quadrilateral space but further exposure of the nerve must be done through a posterior incision described later.

Radial Nerve. The radial nerve is exposed in the arm through an incision on the dorsal surface of the upper one-half of the arm beginning at or above the posterior axillary fold and extending in a straight line distally between the long and lateral heads of the triceps muscle to the middle of the arm. The incision is then continued curving laterally and distally along the line of the musculospiral groove of the humerus into the lateral portion of the distal one-third of the arm between the lateral border of the biceps brachii tendon and the medial border of the brachioradialis muscle to the antecubital fossa. (Figs. 2 and 3C.) In

the upper one-third of the arm the nerve lies deep and dorsal to the humerus between the long and lateral heads of the triceps muscle and passes into the mid one-third of the arm on the dorsal surface of the lateral intermuscular septum beneath the lateral head of the triceps muscle where it passes through the hiatus onto the ventral surface of the septum. In the mid-arm the nerve may be exposed by either enlarging the hiatus and mobilizing the nerve under the lateral triceps head or, if necessary, the lateral triceps head may be severed at right angles to its fibers and later repaired without harm to it. In the distal one-third of the arm the nerve is buried between the biceps musculotendinous junction and the brachioradialis origin, lying directly on the humerus. It is more readily exposed in this region than elsewhere in the arm. As the nerve extends into the antecubital fossa it lies beneath the medial border of the brachioradialis muscle along the lateral boundary of the fossa, and after extending past the region of the elbow joint it divides into its superficial and deep branches. Exposure of the nerve at its bifurcation requires extension of the skin incision for 5 to 6 cm. into the upper one-third of the forearm along the medial border of the brachioradialis muscle curving it laterally on the dorsolateral aspect of the forearm over the region of the neck of the radius. (Figs. 3C and 2.) The superficial branch may be followed distally beneath the brachioradialis muscle, but to expose it in the middle and distal one-third of the forearm the incision must be made parallel to the medial border of the muscle. The deep branch is well exposed beneath the brachioradialis muscle where important motor branches begin to arise and it may be followed to its entrance into the substance of the supinator muscle at the neck of the radius.

In the forearm the dorsal interosseous, the continuation of the deep branch of the radial nerve, is exposed through a longitudinal incision on the dorsal surface of the forearm midway between the radius and ulna. It extends from the level of the head of the radius into the distal one-third of the forearm. (Fig. 2.) The extensor fascia is incised between the extensor carpi radialis and the extensor digitorum communis muscles. The tendons and fused fibers of these two muscles are separated proximally to the head of the radius where the inferior border of the supinator muscle is

FIG. 2. Incision for exposure of the radial nerve in the arm and the dorsal interosseous nerve in the forearm. The portion of the incision for exposure of the nerve in the elbow region is shown in Figure 3C.

exposed. The dorsal interosseous nerve lies on the interosseous membrane and may be followed distally into the mid or lower forearm and proximally to its disappearance beneath the inferior border of the supinator muscle. Proximal to the latter level the skin incision is extended in a curved direction toward the antecubital fossa and the deep branch further visualized first by exposing it proximally as it enters the supinator beneath the brachioradialis muscle and then by exposing it distally under the supinator muscle as it curves around the neck of the radius by severing the dorsal portion of the supinator. It is at the aforementioned site that important wrist and finger extensor branches arise and great care must be taken to avoid injuring them. In addition deep radial or dorsal interosseous nerve injury associated with fractures of the head and/or neck of the radius is almost uniformly irreparable because the nerve lies in such close proximity to the bone that fracture with any degree of displacement invariably contuses or lacerates an extensive portion of the nerve. (Fig. 3.)

Median Nerve. The median nerve in the arm and antecubital fossa is exposed through an incision on the medial surface of the arm situated at the junction of its ventral one-third with its dorsal two-thirds beginning at the anterior axillary fold and extending distally along

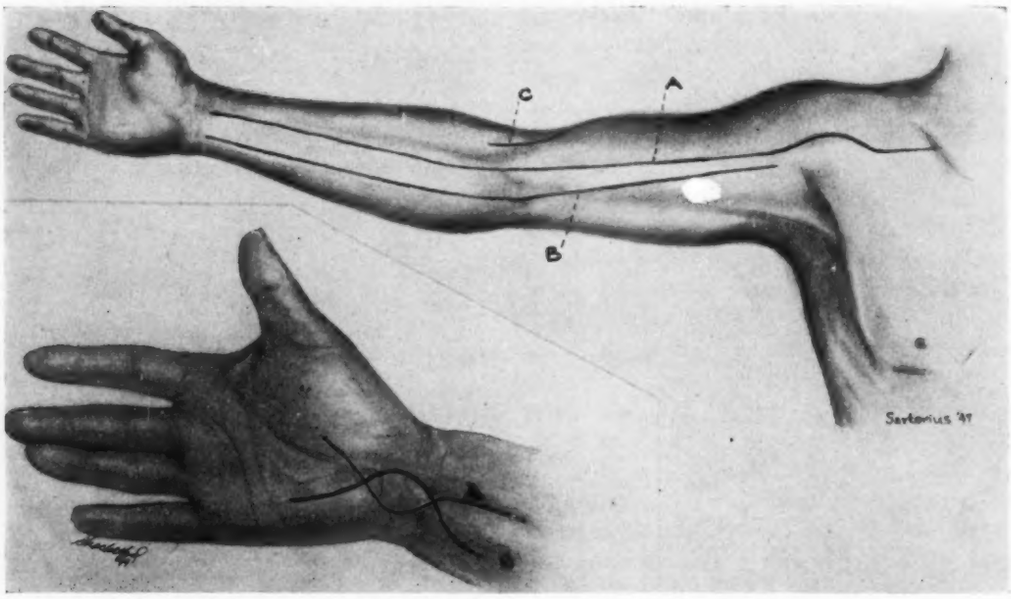

FIG. 3. A, incision for exposure of the infraclavicular portion of the brachial plexus, the neurovascular bundle in the arm and the median nerve in the antecubital fossa and forearm; B, incision for exposure of the ulnar nerve in the arm and forearm; C, distal end of the incision for exposure of the radial nerve in the arm. Inset, incisions for exposure of median (*A*) and ulnar (*B*) nerves at wrist and in the palm.

the course of the neurovascular bundle into the antecubital fossa. In the distal one-fourth of the arm the incision is curved laterally over the medial border of the biceps brachii tendon through the center of the antecubital fossa and into the upper one-third of the forearm. (Fig. 3A.) After incising the deep fascia ventral to the medial intermuscular septum the pulsation of the brachial artery is identified and the median nerve is located along its ventral border, slightly lateral to it and usually just beneath the medial border of the biceps muscle. In some instances the nerve may be buried in the fibers of the biceps muscle in the mid one-third of the arm and beneath the musculotendinous junction of the biceps in the distal one-third of the arm and antecubital fossa. No branches arise from the median nerve in the arm, except in rare instances in which small motor fibers to the biceps and medial head of the triceps muscles have been observed. These small fibers are of no functional significance and may be sacrificed if they interfere with nerve repair.

In the antecubital fossa the lacertus fibrosus covers the median nerve and brachial artery and this structure is incised along the course of the nerve into the upper forearm. The median nerve lies along the ulnar border of the brachial artery and extends into the upper one-third of the forearm in a slightly oblique direction parallel to the radial border of the medial head of the pronator teres muscle. At the inferior portion of the antecubital fossa it extends deeply into the upper forearm, first beneath the medial head of the pronator teres, then between the medial and lateral heads beneath this muscle and the origin of the long flexor muscles. The first motor fibers of the median nerve arise in the antecubital fossa and extend into the pronator teres heads.

The median nerve in the forearm is exposed through an incision situated in the middle of the forearm midway between the radius and ulna extending from the antecubital fossa to the level of the styloid process of the radius. (Fig. 3A.) After incising the deep fascia dissection of the nerve will vary depending on whether the injury is in the proximal or distal portion of the forearm. When the injury is in the upper one-half of the forearm and if the nerve defect is in excess of 5 cm., the most satisfactory procedure is transposition of the nerve to a subcutaneous or subfascial location. This is easily and rapidly accomplished by separating the bellies of the brachioradialis and flexor carpi radialis muscles and completely exposing the pronator teres muscle down to its

insertion into the radius. At a point about 1 cm. from its insertion the tendon is severed parallel to the radius and the entire muscle retracted ulnarward. This exposes the deeply situated median nerve on the interosseous membrane where it passes between the heads of the pronator teres muscle. All the important long flexor branches arise at this level in the upper one-third of the forearm. With such exposure these branches are protected and, if necessary, may be readily separated from the main trunk of the median nerve into the antecubital fossa. Also, the proximal portion of the nerve may be brought out superficial to the muscles either subfascially or subcutaneously in order to overcome a large defect. Repair of the previously severed pronator teres tendon is easily accomplished and large defects in the median nerve are overcome without suture line tension. The dissection of the median nerve proximally beneath these muscles and distally beneath and between the heads of the pronator teres muscles is not only more difficult and time-consuming but also more apt to result in injury to some of the long flexor branches. When the injury is in the lower one-half of the forearm, the tendons of the flexor carpi radialis and palmaris longus muscles are separated, exposing the musculotendinous portion of the flexor digitorum sublimis. The latter muscle is retracted ulnarward and the median nerve located beneath it on the ventral surface of the flexor digitorum profundus tendons. The volar interosseous branch of the median nerve is often identified along its radial border and distally the nerve lies relatively superficial between the flexor carpi radialis and palmaris longus tendons.

At the wrist joint and in the upper one-third of the palm the median nerve is exposed through an incision similar to that previously mentioned which curves toward the pisiform bone and from there in a semilunar direction distally and obliquely across the transverse carpal ligament to end along the ulnar border of the thenar region. (Fig. 3, inset *A*.) The median nerve is first identified at the wrist joint between the flexor carpi radialis and palmaris longus tendons after which the semilunar flap of skin is reflected radialward to expose the transverse carpal ligament, the palmar aponeurosis and the origin of the thenar muscles. The transverse carpal ligament may be incised over the course of the median nerve to obtain distal exposure and if suture of the nerve makes repair of the severed ligament impractical, it may be left unsutured or repaired in its distal portion only. If exposure of the terminal digital branches of the median nerve in the palm is desired, the incision may be extended distally toward the web between the index and middle fingers. A longitudinal incision across the wrist joint into the upper portion of the palm is quite satisfactory and has no significant disadvantage compared to the incision described.

Ulnar Nerve. The ulnar nerve in the arm and at the elbow is exposed through an incision on the medial surface of the arm beginning at the anterior axillary fold at the site of the neurovascular bundle and directed distally along the course of the neurovascular bundle to the mid-arm where it extends slightly dorsal to the bundle to a point about 2.5 cm. ventral to the medial epicondyle of the humerus. The distal portion of the incision makes a slight curve ventral to the medial epicondyle before ending in the upper one-third of the forearm. (Fig. 3B.) The dorsal skin flap is reflected at the elbow exposing the medial epicondyle of the humerus and the groove for the ulnar nerve after which the deep fascia ventral to the medial intermuscular septum is incised and the neurovascular bundle identified. The ulnar nerve in the upper arm lies dorsal and slightly lateral to the brachial artery; in the mid-arm region it extends along the ventral surface of the medial intermuscular septum and it usually passes through the septal hiatus slightly below the mid-arm level. From there it courses dorsally, accompanied by the ulnar artery and vein, through the fibers of the medial head of the triceps muscle into the distal one-third of the arm where it becomes more superficial and curves around the medial epicondyle of the humerus into the groove for the ulnar nerve. Here it becomes covered by a thick layer of deep fascia and the fibromuscular origin of the flexor carpi ulnaris muscle. There are no branches arising from the ulnar nerve in the arm. Usually the first branch identified is the small articular branch to the elbow joint which has no important function and may be sacrificed. In order to repair the ulnar nerve in the arm the hiatus in the intermuscular septum is opened and the nerve completely mobilized. Unless the defect is very small (less than 2 cm.), it is necessary to transpose it anterior to the medial epicondyle.

Transposition of the ulnar nerve anterior to

the medial epicondyle is accomplished by mobilizing it generously above and below the epicondyle. The proximal mobilization is done first, after which the distal mobilization is done by incising the deep fascia throughout the upper one-third of the forearm beginning in the middle of the groove for the ulnar nerve and extending distally for about 7.5 cm. in a line directed toward the pisiform bone. The fascia and heads of origin of the flexor carpi ulnaris muscle are separated which exposes the ulnar nerve and its branches to the flexor carpi ulnaris and flexor digitorum profundis muscles in the upper one-third of the forearm. The nerve is separated from the artery and is lifted from the humeral groove and from the heads of the flexor carpi ulnaris; in so doing the motor branches are separated proximally from the main trunk for 2 to 2.5 cm., after which the nerve is transposed well anterior to the medial epicondyle. By incising the septal hiatus and dissecting the nerve well into the upper one-third of the forearm, its course is made almost parallel to the median nerve as far as the elbow, directly into the upper forearm between the heads of the flexor carpi ulnaris muscle, thereby avoiding an acute angle in the course of the nerve. The incision in the flexor fascia is loosely closed leaving an opening for the nerve about 1.5 cm. long to prevent constriction at this point. The method of transposition in which the common flexor origin is separated from the medial epicondyle, beneath which the ulnar nerve is transposed, has been found to be an unsatisfactory method because in most instances dense scarring occurs around the nerve at this point. It has been necessary on a number of occasions to remove the nerve from this situation and transpose it as described previously in order to obtain the maximum recovery possible.

The ulnar nerve in the forearm is exposed through an incision arising in the upper one-third of the forearm which is a continuation of the incision for transposition. It is extended distally along the course of the ulnar nerve and the radial border of the flexor carpi ulnaris tendon to the level of the wrist joint about ½ cm. radial to the pisiform prominence. (Fig. 3 B.) The flexor fascia is incised along the radial border of the flexor carpi ulnaris and medial retraction of the belly and tendon of this muscle exposes the ulnar nerve and vessels covered by a thin transparent layer of fascia. This fascia is incised and the ulnar nerve is dissected proximally well into the upper forearm beneath the muscle belly. It is dissected distally by separating the fibers of the flexor carpi ulnaris into the upper forearm. The important long flexor branches arise in the upper one-third of the forearm beneath the muscle belly, while distally, the dorsal sensory branch of the ulnar nerve arises from the main trunk about 2.5 to 3 cm. proximal to the wrist joint and often accompanies the main trunk to the wrist joint before it extends dorsally to the back of the hand. When a defect in excess of 6 to 7 cm. exists, the nerve is transposed anterior to the medial epicondyle and subcutaneously in the forearm similar to the method previously described.

At the wrist joint and in the upper one-third of the palm the ulnar nerve is exposed through an incision similar to that for the median nerve except that the curvature of the incision is in the opposite direction toward the styloid process of the radius. (Fig. 3, inset B.) The transverse carpal ligament is not disturbed because the nerve extends superficial to the ligament into the hypothenar region.

Median and Ulnar Nerves. The incision for exposure of both nerves in the arm is similar to that for the ulnar nerve, except that in the distal one-third of the arm and in the antecubital fossa the incision is placed about 1 cm. nearer the course of the median nerve than described for the ulnar nerve. In the forearm a similar displacement of the incision about 1 cm. radialward affords better exposure for both nerves.

Femoral Nerve. Limited experience with femoral nerve injuries amenable to surgical exploration indicates that satisfactory exposure is obtained through a longitudinal incision in the upper one-third of the anterior surface of the thigh parallel to the lateral border of the femoral artery. It begins 1.5 cm. distal to the inguinal ligament and extends approximately 7 cm. distally into the upper thigh. The deep fascia along the medial border of the sartorius muscle is incised, after which retraction of this muscle and iliopsoas muscle will expose the femoral trigone of Scarpa. The femoral artery pulsation is identified; lateral to it is the femoral nerve. A short distance below the inguinal ligament the nerve bifurcates into numerous motor and sensory branches and injury to the nerve proximal to its bifurcation which could

be surgically repaired has not been encountered by the authors.

Sciatic Nerve. The most satisfactory exposure of the sciatic nerve in the buttock is through an incision arising slightly below the posterosuperior iliac spine extending obliquely downward parallel to the superior border of the gluteus maximus muscle to the medial border of the greater trochanter of the femur; then in a curved direction around the inferior lateral quadrant of the buttock to the middle of the gluteal fold into the upper one-third of the center of the posterior surface of the thigh. (Fig. 4.) The superficial tissues are reflected to expose the superior, lateral and inferior aspects of the gluteus maximus muscle and the greater trochanter. The deep fascia along the superior and inferior borders of the muscle is incised and the deep surface of the muscle separated. Next an incision is made through the tendinous insertion of the gluteus maximus into the greater trochanter and leaves about 1 cm. on the trochanter for reattachment. The gluteus maximus muscle is then reflected medially which exposes the sciatic nerve from the greater sciatic foramen to the upper thigh (or gluteal fold). The piriformis muscle may be retracted or partially severed to expose the greater sciatic notch completely. The superior and inferior gluteal nerves and vessels appear along the superior and inferior borders of the piriformis muscle and the posterior cutaneous nerve of the thigh lies medial to the sciatic nerve. This method of exposure is more satisfactory than incising the gluteus maximus muscle fibers more medially along the anatomic course of the sciatic nerve in the buttock.

The incision is continued distally along the center of the thigh into the upper popliteal fossa where it may be extended through the middle of the popliteal fossa or directed laterally parallel to the biceps femoris tendon. The posterior cutaneous nerve of the thigh is located on the dorsal surface of the deep fascia; the latter is incised in the middle of the thigh and the borders of the hamstring muscles identified. The medial border of the long head of the biceps femoris muscle is separated from the lateral border of the semitendinosus and semimembranosus muscles which exposes the sciatic nerve situated between them and beneath the long head of the biceps femoris muscle in the upper one-third of the thigh. Throughout the thigh the sciatic nerve extends

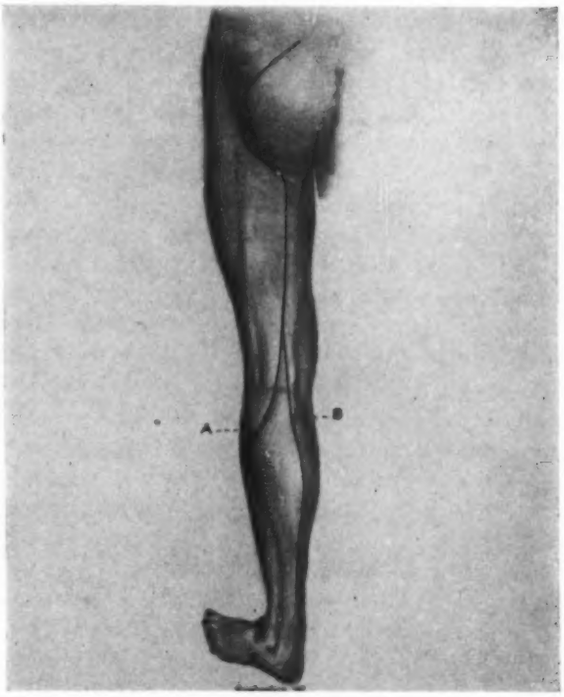

FIG. 4. Incision for exposure of the sciatic nerve in the buttock and in the thigh. A, distal end of the incision for exposure of the common peroneal nerve in the popliteal space and upper leg; B, incision for exposure of the tibial nerve in the popliteal space in the leg. The distal one-third of this incision is placed mid-way between the internal malleolus and Achilles' tendon, more medial than indicated in the illustration.

along the surface of the adductor magnus muscle and the division of the nerve into tibial and peroneal components is readily identified through its transparent sheath. The separation of the tibial and peroneal components usually occurs in the upper popliteal fossa but it may be found as high as the mid one-third of the thigh and the motor branches to the hamstring muscles take origin in the upper and middle one-third of the thigh.

In the popliteal fossa the incision is continued distally through its center if the tibial nerve is to be mobilized and it is extended in a curved direction laterally, parallel to the medial border of the biceps femoris tendon, if the common peroneal nerve is to be exposed. The deep fascia of the popliteal fossa is incised along the course of the tibial or peroneal components. The popliteal artery lies medial and deep to the tibial nerve and the vein often crosses or lies superficial to it. In the inferior portion of the popliteal fossa the motor fibers to the gastrocnemius, plantaris and soleus muscles usually arise, and in the mid or upper

popliteal fossa the medial sural cutaneous nerve courses lateral or superficial to the tibial nerve into the upper one-third of the leg. The tibial nerve may be exposed for a relatively short distance into the upper leg by separating the lateral head of the gastrocnemius from the plantaris muscle but it soon becomes deeply situated beneath the calf muscles. The common peroneal nerve courses distally medial to and sometimes partly covered by the medial border of the biceps femoris musculotendinous junction, and in the mid-popliteal fossa the lateral sural cutaneous nerve arises from its medial aspect. It gives rise to no other branches until it bifurcates at the neck of the fibula.

Common Peroneal Nerve. The common peroneal nerve is exposed in the leg by continuation of the incision along the medial border of the biceps femoris tendon until the neck of the fibula is reached where the incision crosses obliquely into the anterolateral surface of the leg midway between the fibula and the anterior border of the tibia where it extends distally to the mid one-third of the leg. (Fig. 4A.) At the posterior border of the neck of the fibula the common peroneal nerve is covered by a dense layer of fascia which upon incision exposes the bifurcation of the nerve at the neck of the fibula into its deep and superficial components. The recurrent articular branch to the knee joint and usually a large motor branch to the tibialis anterior muscle arise at the bifurcation.

The deep peroneal component extends anteriorly and inferiorly, deeply situated in the fibers of the peroneous longus and extensor digitorum longus muscles and comes to lie on the interosseous membrane deeply placed between the tibialis anterior and extensor digitorum longus muscles which are separated to expose the nerve in the leg. In the upper one-third of the leg the important motor fibers arise after which the nerve becomes small in its course distally. Suture of the nerve in the region of the neck of the fibula and for 1 to 2 cm. distally may often be accomplished in a fairly satisfactory manner, but further distally the nerve is small and large defects cannot be repaired.

The superficial peroneal component extends distally in the substance of the peroneous longus muscle and soon decreases in size after the motor branches arise. Only defects of relatively small size may be repaired distal to the neck of the fibula.

Not infrequently the common peroneal nerve is lacerated at its bifurcation; when this occurs, the most satisfactory method is suturing the borders of the deep and superficial components together forming a single nerve trunk which may then be sutured to the proximal main trunk of the common peroneal nerve. Although the authors have had no experience with resection of the neck of the fibula in peroneal nerve repair as described by Livingston et al.,[5] this procedure may be useful in lacerations situated at the point of bifurcation.

Tibial Nerve. The incision for exposure of the tibial nerve in the leg begins in the center of the lower popliteal fossa and extends distally through the middle of the upper 5 cm. of the leg after which it curves medially for 2 cm. through the calf to the mid-leg. At this point it extends distally parallel to the medial border of the Achilles tendon and passes the ankle joint midway between the internal malleolus and medial border of the Achilles tendon curving anteriorly toward the posterior aspect of the arch of the foot. (Fig. 4B.) The tibial nerve is identified in the distal one-half of the leg by incising the fascia along the medial border of Achilles' tendon and separating the fat from the deep fascia beneath it. The tibial nerve and posterior tibial vessels are covered by a transparent layer of fascia on the dorsal surface of the tibialis posterior muscle and dissection distally is easily accomplished down to the internal malleolus where the medial and lateral plantar divisions arise. In the mid and upper one-third of the leg the nerve and vessels are deeply situated on the dorsal surface of the tibialis posterior muscle and exposure is best accomplished by separating the medial border of the Achilles tendon and the medial attachment of the soleus muscle from the tibia. In this manner the muscles are retracted laterally and the tibial nerve and vessels and its motor branches are completely exposed in the middle and upper one-third of the leg. In the lower popliteal fossa the medial head of the gastrocnemius muscle may be separated and the tibial nerve mobilized beneath it. Incision through the substance of the gastrocnemius and soleus muscles is bloody and time-consuming and is more likely to result in injury to intact

motor branches. Throughout the leg the venae comites of the posterior tibial artery are closely related to the tibial nerve and experience has shown that excessive cauterization of these vessels results in troublesome postoperative thrombosis with prolonged edema of the foot and lower leg. By employing an extensive dissection of the tibial nerve through the leg and popliteal fossa defects of 8 to 9 cm. may be repaired which cannot be accomplished by mobilization limited to the middle and lower one-third of the leg.

CONCLUSIONS

1. A satisfactory method for exposing all of the major peripheral nerves is described.

2. Accurate planning of the incision and allowance for proximal and distal extension is important because it saves time, makes the identification of the nerve and related structures easier and decreases the vascularity of the operative field.

3. The improper planning of the skin incision and exposure of some of the peripheral nerves may actually compromise to an important degree the size of a defect that may be repaired resulting in unnecessary suture line tension.

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REGIONAL ENTERITIS*

RESULTS OF SURGICAL TREATMENT

LOUIS T. PALUMBO, M.D. AND SAMUEL C. WITTMER, M.D.

Des Moines, Iowa

SINCE the original report in 1932 of Crohn and his associates[3] on this subject many reports have appeared in the literature.[1–24] In spite of this, their original report continues to remain the most accurate and complete treatise on this subject. However, in 1828 Abercrombie[6,21] reported a case which fulfilled the same pathologic changes in the terminal ileum that have been reported in the American literature.

This disease entity remains obscure as to the etiologic factor or factors. In the past twenty years innumerable reports have definitely established that the process is not necessarily limited to the terminal ileum. Any segment of the small bowel and even portions of the ascending colon become involved. The disease process is of a non-specific nature, and because of this fact, a variety of terms have been used to describe it: regional ileitis, terminal ileitis, chronic cicatrizing enteritis, segmental enteritis, non-specific granuloma of the intestine, chronic ulcerative ileitis, Crohn's disease, chronic enteritis, ileocolitis and pseudo-cancer.

Basically the pathologic process is that of a non-specific granulomatous inflammation involving a segment or segments of small intestine and/or colon. In the early phases it is characterized by inflammation, congestion, submucosal edema, irregular hemorrhages of the mucosa and submucosa, and superficial ulcers. This process may continue to the chronic phase which reveals a sharply demarcated, indurated, leathery, rubber tube or garden hose type of bowel.[13,24] The bowel wall is thickened, resulting in a narrowed lumen which may have many shallow, longitudinal ulcers at the site of the mesenteric attachment. The mesentery is thickened and contains many large edematous nodes. Adhesions are common between the adjacent loops of bowel. The ulcerative process may extend through the bowel wall, producing fistula formation with other loops of bowel or with the urinary bladder, rectum or vagina. Also, the fistulous process may extend externally to involve the anterior abdominal wall or pararectally or anally, similar to a fistula-in-ano.

The disease is most common in young adults; about 80 per cent of cases occur in patients under forty years of age.[6,10] However, the disease has been reported in patients from nine months of age to seventy-one years.[6] It occurs more frequently in males and appears to develop in individuals who exhibit instability of the autonomic nervous system. There appears to be a definite increase in the incidence of this condition.[8]

The segments of bowel that may be involved are revealed in a study by Ravdin[22] in 390 cases reported: 66 per cent occurred in the terminal ileum, 20 per cent in the terminal ileum and cecum, 6 per cent in the terminal ileum, cecum and ascending colon, 5 per cent in the jejunum and 3 per cent in the mid-ileum.

The symptoms of a typical case of enteritis are characterized by diarrhea, abdominal pain, low grade fever, progressive anemia, loss of weight, eventually an intra-abdominal mass and often fistula formation. The diarrhea is an outstanding feature of the disease and is usually preceded by spasm of abdominal pain. The stools are mushy, semi-formed or liquid and may contain mucus.

The psychic manifestations are sometimes so prominent that the true organic pathologic condition is overlooked. This is readily apparent in a review of the literature in that the diagnosis is frequently established rather late in the disease, as shown by Crohn.[6]

The physical examination may reveal an abdominal mass usually in the right lower

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quadrant, presence of an external or internal fistula, rectal fistula or abscesses, evidence of low grade intestinal obstruction, anemia and evidence of loss of weight.

Motor meal studies of the small bowel and barium enema with air contrast studies of the colon are valuable adjuncts in diagnosis. However, the absence of roentgen evidence does not in any manner preclude the diagnosis. The x-ray findings may reveal clumping, segmentation, puddling of the barium column in the small bowel, narrowing and irregularity in the mucosal luminal pattern, and hypermotility with marked increase in transit time. In diseased segments with advanced pathologic changes the "string sign" as described by Kantor[13] is pathognomonic. This finding is characterized by a thin, irregular, linear shadow resembling a cotton string from the last visible loop of small bowel to the ileocecal valve. Injection of the external fistula with lipiodol may be valuable in revealing a communication with a diseased segment of bowel.

RESULTS

During the past six years sixteen patients were treated surgically at this hospital. This represents an incidence of 0.06 per cent of 26,500 surgical admissions during this period of time.

The average age was 35.5 years; the youngest patient was twenty-one and the oldest fifty-eight years. The greatest number were in the twenty-one to twenty-nine year age groups. (Table I.) The average duration of symptoms prior to their admission to this hospital was twenty-seven and one-half months; the shortest was six hours and the longest ten years. The most frequent complaint was abdominal pain, cramps and diarrhea. The other symptoms were weight loss, nausea, vomiting, malaise and anorexia. The physical findings revealed abdominal tenderness in all cases, a palpable abdominal mass in six (28 per cent) and an abdominal wall fistula in two (13 per cent). (Table II.)

TABLE I
INCIDENCE ACCORDING TO AGE

Age Groups	No. of Patients	Per cent
21–29	6	38
30–39	5	31
40–49	1	6
50–59	4	25
Totals	16	100

The x-ray motor meal study of the small bowel revealed narrowing of the lumen, hypermotility, clumping and segmentation with puddling of the barium column in 75 per cent of the cases. The x-rays did not reveal any abnormalities in three patients who had definite changes at the time of surgical intervention. In five patients roentgenographic studies were not conducted because these patients were admitted during an acute initial episode and were diagnosed preoperatively as having acute appendicitis.

TABLE II
SYMPTOMS AND PHYSICAL FINDINGS

Symptoms	No.	Per cent	Physical Findings	No.	Per cent
Abdominal pain	13	81	Abdominal tenderness	16	100
Diarrhea	6	37	Abdominal mass	6	28
Weight loss	4	25	Abdominal wall fistula	2	13
Nausea and vomiting	3	19			
Malaise	2	13			
Anorexia	1	6			

Ten or 63 per cent of the patients were operated upon prior to their admission here. Of this number one had a resection of the terminal ileum, five had an appendectomy, three had an anal fistulectomy and one had a resection of the terminal ileum and an ileostomy.

The sixteen patients were classified into three stages of the disease, based upon the gross pathologic changes present at the time of surgery. (Table III.)

The surgical procedures performed in the acute cases, Stage I, were appendectomy in four and an exploratory laparotomy in one, representing 31 per cent of the series. In this group no evidence of recurrence or other complications was noted. In the one case with

TABLE III
CLASSIFICATION ACCORDING TO GROSS PATHOLOGIC CHANGES

Stages	No. of Patients	Per cent
I	5	31.25
II	1	6.25
III	10	62.50
Totals	16	100

Stage II only an exploratory laparotomy was accomplished.

In the remaining ten patients, Stage III, in five (50 per cent) an ileotransverse colostomy with ileal exclusion was accomplished; in three (30 per cent) a one-stage resection of the terminal ileum and ascending colon with an ileotransverse colostomy was performed; in one (10 per cent) excision of fistulous tract of the abdominal wall and local resection of ileum, followed later by resection of portion of jejunum and jejunotransverse colostomy, were accomplished; and in one (10 per cent) a jejunotransverse colostomy was performed. No deaths occurred in this entire series.

Seven postoperative complications developed in five of the sixteen patients, an incidence of 31 per cent. The majority occurred in the wound. (Table IV.)

TABLE IV
POSTOPERATIVE COMPLICATIONS

Type	Number
Wound abscess	2
Fistula, abdominal, recurrent	1
Hematoma, intraperitoneal	1
Infarction, pulmonary*	1
Peritonitis, bile*	1
Thrombophlebitis, acute*	1

* All in same patient.

The following incisions were employed: in eight (36 per cent) a McBurney incision; in seven (31 per cent) a right transverse muscle-splitting mid-abdominal incision; in six (28 per cent) a left oblique muscle-splitting incision; and in one (5 per cent), left paramedian. Actually twenty-two surgical procedures were performed at different times in the sixteen patients. The closure of the abdominal incisions was accomplished by using catgut in 55 per cent, silk in 36 per cent and wire in 9 per cent of the cases.

Sixty-two per cent of the patients were followed up for an average period of 20.5 months, with the longest follow-up being forty-four months. Of the group followed up no recurrences have occurred to date.

COMMENT

Regional enteritis is a chronic disease which exists for a long period of time before a diagnosis is established. In the acute phase it presents a problem of an acute condition of the abdomen and is frequently diagnosed as acute appendicitis preoperatively. Controversy exists as to whether or not an appendectomy should be performed during the acute early stages of the disease. In this series of five cases in the acute phase four appendectomies were performed without any serious sequelae.

This is a disease which has frequent recurrences, estimated in some series to be high as 20 to 25 per cent. It should be noted that a fairly large number of conditions in the acute phase, Stage I, will subside without the aid of definitive therapy, and that many patients in this group will have no further trouble. To date there have not been any recurrences in our series. In one-half of the cases a short-circuiting operation was performed, whereas in one-third of the group a one-stage resection and ileotransverse colostomy was the operation of choice. In both series there were no deaths, serious complications or recurrences following surgery.

It is the opinion of the senior author that if the patient's condition permits and the local pathologic disorder is resectable, a one-stage procedure should be accomplished, that is, resection of the diseased bowel and an ileotransverse colostomy. We prefer an end-to-end open anastomosis. It appears inadvisable to leave advanced disease in an abdomen even though it has been sidetracked. In other diseases with an advanced pathologic condition an attempt is made to remove it. This diseased segment of bowel can be a source of further trouble and can cause continued bowel irritation and activity; a focus for absorption of toxic products and possible spread to other segments of uninvolved bowel. In this connection it is imperative that

if a resection is performed it be carried beyond the limits of disease into normal segments of the bowel. "Skip areas" must be carefully watched for and these segments removed. It is possible that the recurrences which have been reported are actually "skip areas" which have been overlooked at the time of the original surgery and have progressed at a later date to the more advanced stages of the disease.

Dennis[7] and Thorek[23] have advocated vagotomy in the treatment of selected cases of regional enteritis. It is the senior author's opinion that such a procedure has some degree of merit. However, it appears that a more advanced step in this direction would be more feasible if the basic physiology and nerve distribution to the gastrointestinal tract is considered.

There appears to be a close correlation between peptic ulcer, ulcerative colitis, nonspecific granuloma of the colon and regional enteritis. These conditions seem more likely to occur in patients who reveal instability of the autonomic nervous system. The disease complex is dependent upon that portion or division of the autonomic nervous pathways previously involved in such a disturbance. It is possible that the disease process or changes which occur are primarily initiated by changes mediated through abnormal stimulation of the autonomic nervous system. With stimulation of the visceral efferent components of the thoracolumbar and splanchnic division of the sympathetic system local and diffuse vasospasm may result. These changes could result in the development of local necrosis and ulceration of the bowel. Along with this local irritation the parasympathetic innervation, by way of the vagus fibers, could bring about excessive gastrointestinal activity in secretions and motor functions. A combination of these two abnormal stimulations could result in tissue changes which are seen in the early phases of the various diseases mentioned heretofore. Once this process is initiated by such action, secondary infection and other changes could occur to propagate and continue the changes to a chronic stage of a non-specific type of inflammatory reaction.

Upon this concept it appears reasonable to assume that in the early phases of these various conditions an operation on the pathways of the autonomic nervous system concerned with the innervation of the organs or tissues involved may bring about improvement and even arrest of the disease process. If performed early enough it may reverse the changes to restore the tissues or organs to normal.

In this connection, in cases of early regional enteritis and non-specific ulcerative colitis it would be more feasible to interrupt portions of both the sympathetic and parasympathetic nerve supply to the structures involved. It is suggested that only a right vagotomy or vagus resection, a bilateral splanchnicectomy and associated lower dorsal and upper lumbar ganglionectomy be accomplished to bring about the maximal benefit. In the event a complete denervation of the parasympathetics of the lower left half of the colon is necessary, as in the cases with ulcerative colitis, a left presacral (parasympathetics) neurectomy should also be performed.

Vagotomy alone, advocated by Dennis and Thorek, is only a partial attack upon the nerve supply to these structures. It appears that dividing the left vagus below the diaphragm contributes very little to the denervation of the upper and lower intestinal tract and only results in further undesirable gastric disturbances. It is possible, too, to divide the right vagus nerve below its gastric branches and thereby eliminate the disturbances in gastric function. By means of this method, the gastroplegia following vagotomy could be eliminated and thereby minimize several of the undesirable sequelae of a vagus resection.

SUMMARY

Regional enteritis continues to be a disease of non-specificity, the etiology being unknown. It may involve any segment of the small bowel and/or the right half of the colon. The disease progresses through several stages, and when reaching the advanced stages requires surgical intervention.

In the advanced stages a one-stage resection of the portions of bowel involved and an ileotransverse colostomy appears to be the treatment of choice. In poor risk patients and/or in those cases in which the disease process cannot be resected with safety a short-circuiting operation consisting of complete ileal exclusion with an ileotransverse colostomy is the procedure of choice.

A theory is proposed in this article that this condition, as well as ulcerative colitis, nonspecific granuloma of the colon and peptic

ulcer, may be initiated by an imbalance of portions of the autonomic nervous system. Upon this basis the favorable effects of vagotomy as reported by several clinicians may be explained. However, it is our opinion that a right vagus resection inferior to the origin of the gastric branches, a bilateral splanchnicectomy, a lower dorsal and upper lumbar sympathectomy and an excision of the left presacral parasympathetics would be a more logical procedure.

Sixteen cases of regional ileitis are presented. Of this number five were in Stage I, one in Stage II and ten in Stage III. In the early stages of the disease an appendectomy was performed in four patients during the acute episode. In the advanced group an ileal exclusion with an ileotransverse colostomy was performed in 50 per cent of the patients, and in 30 per cent a one-stage resection of the diseased small bowel and right colon with an end-to-end ileotransverse colostomy was accomplished. There were no deaths and no recurrences.

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MESENTERICOPARIETAL HERNIA*

REPORT OF THREE CASES

ROSCOE C. GILES, M.D., EDWARD DEL BECCARO, M.D., WILLIAM KLINGENSMITH, M.D. AND HERBERT TRACE, M.D.

Chicago, Illinois

INTERNAL hernias as a cause of acute or chronic intestinal obstruction, or of vague recurrent digestive symptoms are relatively rare. The purpose of this article is to report three cases, one of which was tentatively diagnosed preoperatively on the basis of the history and physical findings, the second by one of us (E. D. B.) on the basis of the findings in the first case and the third at the operating table. All three cases were confirmed by operation, with recovery and complete relief of symptoms postoperatively.

From 1937 to 1948 there were ten cases of internal hernias in the Cook County Hospital; of these, four were classified as paraduodenal hernia, one on the left side, one on the right side and two undescribed as to location. We desire to present three additional cases since 1948.

CASE REPORTS

CASE 1. A seventy-two year old white woman was admitted to the Cook County Hospital (No. 44587) on August 22, 1950, with a history of good health up until two years before admission when she had noticed a gradual onset of constipation. Her bowel movements no longer occurred daily, but every two to four days. Along with constipation she had experienced gas pains and distention of the lower abdomen, and often heard gurgling sounds. Her stools were formed and never contained blood by name or symptom, nor had she observed any mucus. For relief she took either cathartic pills or mineral oil, followed by a soap suds enema, which usually gave relief.

For the two months preceding admission the patient had had frequent attacks of belching and heart burn, which she described as a burning sensation beneath the sternum and ascending into her throat, having a sour or bitter taste, coming on five to fifteen minutes after ingestion of food and recurring at intervals two or three times a week. Two weeks before admission nausea and vomiting gradually ensued. Vomitus varied in amount from a cupful to a quart of brownish colored material which tasted sour and occasionally bitter. The attacks came on two or three times a day; the patient often induced vomiting with her finger to get relief. She never noticed blood in the vomitus or experienced any dysphagia.

She had always had a good appetite and ate three meals a day. For the past ten years she had been edentulous but had never worn a denture. She denied the use of alcohol or tobacco. For two weeks previous to admission she had subsisted on potato chips and salads consisting principally of lettuce, tomato and carrots. At no time had she experienced diarrhea or clay-colored, tarry or mucoid stools. No history of jaundice, dark-colored urine or upper quadrant pain was reported. Eight days before admission she began to experience severe colicky pain, which was localized in the epigastrium and radiated to the chest. This was aggravated by food intake but was relieved by spontaneous or self-induced emesis, the passage of flatus or by cathartics or enemas.

The family and past history were non-contributory. There had been no pregnancies or previous operations or hospitalizations.

On admission the patient did not appear acutely ill. She was oriented, somewhat cachetic, with rather loose, flabby integument. Otherwise the general physical examination was essentially negative. The abdomen was scaphoid in the upper half but the lower half was asymmetrically distended, with a bulge present in the left half which seemed to shift with change of position of the patient to the right side. The area involved was dull to percussion with intervening areas of tympany. Bowel sounds were audible, frequent and high pitched. No definite masses could be palpated and no free fluid could be demonstrated. Pressure over the area was uncomfortable but no

* From the Cook County Hospital, Chicago, Ill.

FIG. 1. Case 1. Shows several small loops of distended small bowel in the lower abdomen with gas in the ascending colon and no areas of abnormal radiopacity.

localized tenderness could be elicited. Vaginal examination was negative. Rectal examination revealed inspissated feces. There were no masses or tenderness present over either inguinal or femoral areas. Blood pressure was 140/80; rectal temperature was 99.4°F.; pulse, 80; respiration, 24.

Shortly after admission the patient regurgitated a small amount of brownish mucoid material which was benzidine positive. A scout film of the abdomen was reported as negative for any free air under the diaphragm, or for any radiologic evidence of intestinal obstruction. Repeat film taken seven hours later was reported as showing several loops of distended small bowel in the lower abdomen, with gas in the ascending colon and no areas of abnormal radiopacity. (Fig. 1.) Traces of mineral oil administered orally were recovered in the stool after an enema. Laboratory findings were as follows: hemoglobin 80 gm. per cent; white blood cells 9,480; non-protein nitrogen 43 mg./100 cc.; CO_2 combining power 68 volumes per cent; chlorides 83 mEq.; potassium was 3.4, the normal being 4.28 to 5.8 mEq./L.; total protein was 5.6 gm. per cent, albumin 3.6 and globulin 2.0; serum amylase was 8 units; Kahn test was negative.

Barium enema on August 23, 1950, revealed no pathologic disorder of the colon. Proctoscopic examination presented no pathologic condition up to 21 cm. On August 25th the patient experienced a recurrence of the abdominal cramps with definite visible peristalsis from left to right, associated with metallic gurgling sounds in the lower abdomen. Despite the fact that the patient continued to pass flatus per rectum and had had several small brown stools, and that the oil given per mouth had been recovered in the stool, abdominal distention measured by taping the abdomen began to increase. Her temperature rose to 100°F. Scout film showed a number of loops of dilated small bowel in the left side of the abdomen, with no free fluid levels. After the fluid and electrolytic balance had been established by parenteral fluid administration, and especially after the potassium deficiency had been corrected, a diagnosis was made of small bowel obstruction, probably complete, due to an internal hernia. On August 30th under general anesthesia a left paramedian incision was made. Upon opening the abdomen a number of loops of dilated small bowel were encountered. Tracing these loops upward it was found that they led to a left mesentericoparietal hernial orifice into which the loops disappeared. The opening of the fossa was situated to the left of the vertebral column and on the left side of the duodenum, its orifice pointing to the right on a fold of peritoneum extending downward from the ligament of Treitz, the so-called left paraduodenal fossa. The hernia was reduced by blunt and sharp dissection. Neither the inferior mesenteric artery nor any of its branches were encountered in the immediate vicinity of the hernial orifice. Approximately 22 cm. of the lower jejunem and the ileum were incarcerated. The involved gut was discolored but appeared viable. The small bowel was run down completely and found to be normal. No attempt was made to place sutures in the hernial ring. The patient made an uneventful recovery and left the hospital on the nineteenth postoperative day.

CASE II. A twelve year old Negro girl was admitted to the Cook County Hospital (No.

FIG. 2. Case 11. Chest plate showing no signs of active tuberculosis.

FIG. 3. Case 11. A scout film of the abdomen showing dilated loops of small bowel, with parallel ladding in the upper abdomen.

51-4755) on January 24, 1951, with complaints of cramping abdominal pain of nine days' duration. She had been well until nine days before admission when severe cramp-like pain suddenly developed around the umbilicus and gradually spread throughout the abdomen. The next day the patient began to vomit and two days after the onset of the pain she had the last scanty bowel movement. She continued to pass some flatus up to the time of admission. The pain continued; it was intermittent and cramp-like in character, with the patient fairly comfortable between the pains.

The patient gave no history of a similar previous episode and had always been in good health. Her mother died of pulmonary tuberculosis when the patient was three years old. On physical examination the patient appeared lethargic but not acutely ill. Temperature was 99.8°F. per rectum; pulse, 88; respiration, 20; blood pressure was 110/70; chest examination was negative. On pelvic examination the introitus was virginal and there was no vaginal discharge or tenderness. The rectum contained a small amount of hard stool. The abdomen was moderately distended, soft and slightly tender on deep palpation. Bowel sounds were obstructive in character, with high pitched sounds and rushes.

On admission laboratory data were as follows: urinanalysis was negative; hemoglobin was 75 gm. per cent; red blood count was 4,500,000 and white blood count 5,750; nonprotein nitrogen was 24 mg./100 cc.; chlorides 91 mEq./L., sodium 133 and potassium 5.6; there was no occult blood in the stool. Chest plate showed no signs of active tuberculosis. (Fig. 2.) Scout film of the abdomen revealed dilated loops of small bowel with parallel ladding in the upper abdomen. (Fig. 3.) At the time of admission a diagnosis of partial small bowel obstruction was made. The patient was seen by one of us (E. D. B.) and on the basis of the first case a diagnosis of internal hernia, probably of a mesentericoparietal variety, was made. The possibility of a tubercular peritonitis was considered. Gastric suction was instituted and intravenous fluids administered. The patient was given an enema which was followed by the expulsion of a small amount of fecal material. After eighteen hours her condition remained the same; the abdomen was less distended; however, the bowel sounds were still obstructive in character; the temperature

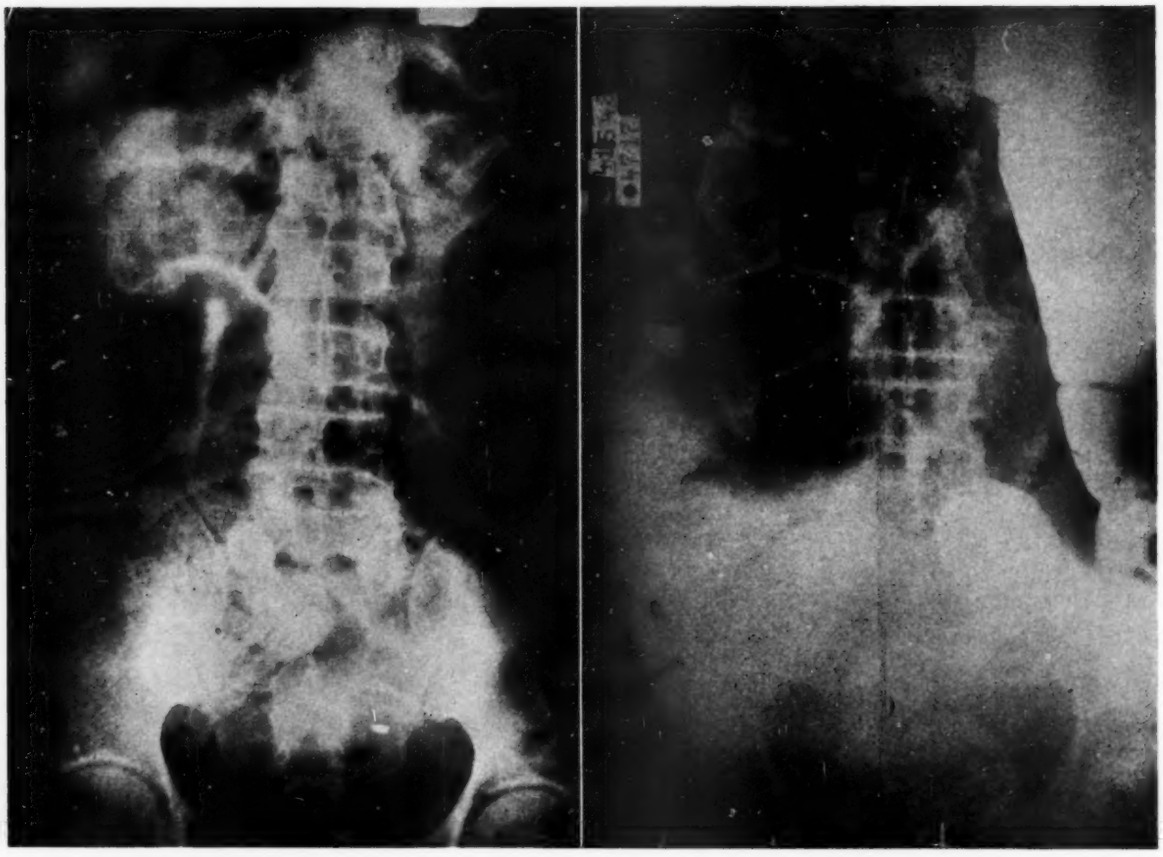

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FIG. 4. Case III. Scout film of the abdomen showing a number of dilated loops of the small bowel mostly on the right side of the abdomen. FIG. 5. Case III. Barium enema showing no pathologic condition in the large bowel.

remained 99.8°F. Laparotomy was performed at this time. Under general anesthesia a right paramedian exploratory incision was made and the terminal ileum was collapsed; this was traced proximally and disappeared into a fold to the left of the ligament of Treitz. The incision was enlarged and several dilated loops of proximal ileum and jejunem were found incarcerated in a left mesentericoparietal hernia. Loops were delivered and, although cyanotic, were found to be viable. The hernial sac appeared to be made up of redundant folds of peritoneum. These folds were separated and the sac was opened. No sutures were placed. No blood vessels were found in the immediate vicinity of hernial edge. The patient made an uneventful recovery and left the hospital on the twelfth postoperative day.

CASE III. T. T., a forty-four year old Negro man, was admitted through the emergency service of the Cook County Hospital (No. 650-639) on April 14, 1948, with an acute abdomen. He was married and the father of seven children, all living and well. His chief complaint was cramp-like abdominal pains of five days' duration. He had been well up to his present illness except that at twenty-five years of age he had experienced bouts of colicky abdominal pain and constipation associated with nausea and vomiting. Five days before admission he ate nothing but peanuts for supper. About 2:00 A.M. he was awakened by a dull cramping pain in the upper abdomen. The following morning he reported for work but was forced to return home because of abdominal cramps and vomiting a greenish watery material. The vomiting relieved the pain.

On admission the abdomen was symmetrically distended. Slight tenderness was present in the left upper quadrant and the epigastrium. Peristaltic sounds were infrequent and high pitched. A small reducible right inguinal hernia was present. There were no feces in the rectum. Rectal temperature was 99.6°F.; pulse, 64; res-

piration, 20; blood pressure 140 systolic, 75 diastolic.

A scout film of the abdomen showed a number of dilated loops of small bowel, mostly on the right side of the abdomen. (Fig. 4.) A barium enema was reported as negative for any large bowel disorder. (Fig. 5.) On April 15, 1948, mineral oil administered the night before passed per rectum. The following day the patient was brought to the operating room with the diagnosis of mechanical intestinal obstruction and was operated on by one of us (H. T.). A right mesentericoparietal hernia was found containing approximately one-half of the upper small bowel. The diameter of the hernial neck was 1½ inches. A number of constricting bands were present about the neck of the sac. About 250 cc. of serosanguineous fluid was free in the peritoneal cavity. The hernia was reduced. The gut was found to be viable. The adhesions about the orifice were freed and the abdomen closed without any attempt at repair. The patient made an uneventful recovery and left the hospital on the fifteenth postoperative day. He was followed in the outpatient department and has remained well.

Although mesentericoparietal hernias are a comparatively rare type of hernia, the literature on the subject is voluminous. In early years many cases were diagnosed at necropsy, many more cases were discovered as an accidental finding in an operation for intestinal obstruction; but with increasing diagnostic measures, including roentgenologic findings, more cases are being diagnosed preoperatively.

Many theories have been advanced as to the etiology of these hernias. Neubauer (quoted by Collins[12]), in 1776, reported a case at necropsy. In 1857 Treitz reported on the anatomy of the various fossae appearing around the duodenum. In 1861 Klob (quoted by Collins[12]) published a case he had discovered at necropsy. Moynihan, in 1906, published a monograph on the subject and described the criteria essential to the diagnosis of a right paraduodenal and a left paraduodenal hernia. He believed that the hernias were due to the failure of fusion between the root of the mesentery and the posterior abdominal wall. Waldeyer believed elevation of the posterior peritoneum because of the blood vessels was a factor. Toldt (quoted by Collins[12]) believed that these hernias were associated with physiologic adhesions in the abdomen. Andrews[1] believed that they were the result of a congenital anomaly in which the small intestines were imprisoned dorsal to the mesentery of the rotating colon. This latter concept has been rather widely accepted. Callander and his associates[7] believe that they are the result of an evagination of an area of the descending mesocolon by the jejunoileum when the descending mesocolon was mobile; that it was not due to a failure or a faulty rotation of the jejuno-ileum. On this basis he explained the classic case of a postarterial herniation described by Haymond and Dragstedt[18] in which the duodenum and the terminal ileum ran anterior to the superior mesenteric artery. Up until 1939, as reported by Collins,[12] 200 cases of left paraduodenal hernia had been reported in the literature, sixty-two on the right. The mortality rate of the patients operated upon was 25.9 per cent due either to failure of the patients to present themselves for diagnosis in time, or to delay in establishing the diagnosis until gangrene or peritonitis had supervened.

The diagnosis is determined largely by exclusion in patients presenting themselves with the symptoms and signs of incomplete or recurrent bouts of intestinal obstruction, at any age, in whom careful search of the hernial orifices present no localized tenderness or masses, and in whom gallstone impaction can be excluded and no other common causes of small bowel obstruction can be demonstrated. Scout films of the abdomen taken at thirty-minute periods for six hours may show the intestine to be in a well defined circular mass. Exner,[16] Taylor,[28] McCarty[24] and Case and his associates[9] reported roentgenologically proved cases in the literature. Ross Golden[17] asserts the condition may be suggested by the presence of two or more loops of distended bowel in an unusual position, for example, either into the right or the upper left quadrant, while the rest of the intestine contains little or no gas. The greater part of the small intestine may be enclosed in the peritoneal sac, either to the right or the left side, or in the middle of the abdomen. Such cases, however, have to be differentiated from the so-called mesenteric pouch hernias in which the incarcerated loops have the appearance of being contained in a sac with rounded contours. Such loops have limited mobility and change little or not at all with changes of position of the patient.

SUMMARY AND CONCLUSIONS

1. Two cases of left mesentericoparietal hernia, and one of right mesentericoparietal hernia, successfully operated, have been presented.

2. The theoretic considerations of etiology have been discussed.

3. A brief review of the recent literature has been made.

4. Diagnostic features leading to a preoperative diagnosis have been emphasized.

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PAINFUL SCARS

R. J. BEHAN, M.D.

Pittsburgh, Pennsylvania

PAINFUL scars which occur after healing of an operative incision are exceedingly annoying both to the surgeon and the patient. The pain may be located directly in the scar or in adjacent tissues, or be referred to other and apparently unrelated areas. In some instances there may not be definite pain, only an uncomfortable, unpleasant sensation very disagreeable to the patient.

The scar may be tender to the touch, even the pressure of the clothing is disagreeable and the constriction of a belt or a waist band almost intolerable. In some cases due to reactions associated with the regeneration of nerve fibers in the scar, irritation of the painful area or even brushing of the spot with a camel's hair brush is sufficient to cause pain of an unpleasant quality and reflex phenomena such as uncontrollable withdrawal, sweating and dilatation of the pupil occur.[2] In some cases pain in scar tissue may also have a comparable etiology to that which occurs in fibrositic lesions.

Temperature changes which occur in the surface of a scar may indicate that metabolic disturbances are possible inciting factors and suggest a relationship to the sympathetic nervous system.

The irritability of cutaneous scars may be partly due to the increased sensitiveness of the superficial regenerating sensory spinal nerve fibers which penetrating the scar have not yet acquired encapsulated corpuscles, but terminate in free nerve endings.[6,11] Naturally, when the free and unprotected fibers are exposed they react to irritation more quickly and easily than do the more heavily protected fibers.

Leriche[7] describes non-myelinated fibers being present at the periphery of the fibrous portion of a cicatrix. He attributes this finding to Howes. After six months there are a few non-myelinated fibers scattered all through the cicatrix, and myelinated fibers are found at the periphery of the cicatrix about the fifth week and all through the cicatrix after the seventh month. These fibers are tortuous, thicker than the normal fibers, and in some cases almost nodular.

Medullated and non-medullated fibers which accompany strands of collagen are immediately under the epithelium and run parallel to it, not like in normal skin where they pass up into the epithelial layer between the papillae. Many terminate in little knobs or clubs. These, Leriche thinks, are small neuromas, and for this reason they may be related to infections in the wound. They are similar to those which Leriche and Fontaine[8] found after division of the sympathetic nerves. (Fig. 1.)

In these cases the pain may not be felt in the scar but in the area of distribution of the involved nerves. This development usually requires time so that the neuromas occur only in scars of long duration.

When pain of an unpleasant quality is present, it has been observed that the nerve nets and terminals subserving the sensation of pain in the skin are isolated from their neighbors instead of interweaving with them as they do in normal skin.[12,13] The unpleasant quality of pain in scar tissues was very similar to that which is elicited from the skin of a normal limb in the course of compression in blood pressure cuff experiments. It was found that the individual nerve fibers, especially those of touch and pain, are affected at different degrees of compression. This corresponds with the sensory phenomena found in scar tissue.

Every surgeon encounters examples of nerve compression when after operation a sensory nerve is enmeshed in *scar tissue*. This is usually a sensory fiber of a branch (usually terminal) of one of the spinal nerves. The pain is generally localized to the area of the scar or is slightly to the proximal side. Generally, pressure over one particular spot is very painful. If this area is resected or is injected with an anesthetizing solution, the pain may disappear and not return. If the treatment has been delayed too long, the irritative changes in the nerve gradually progress centralward

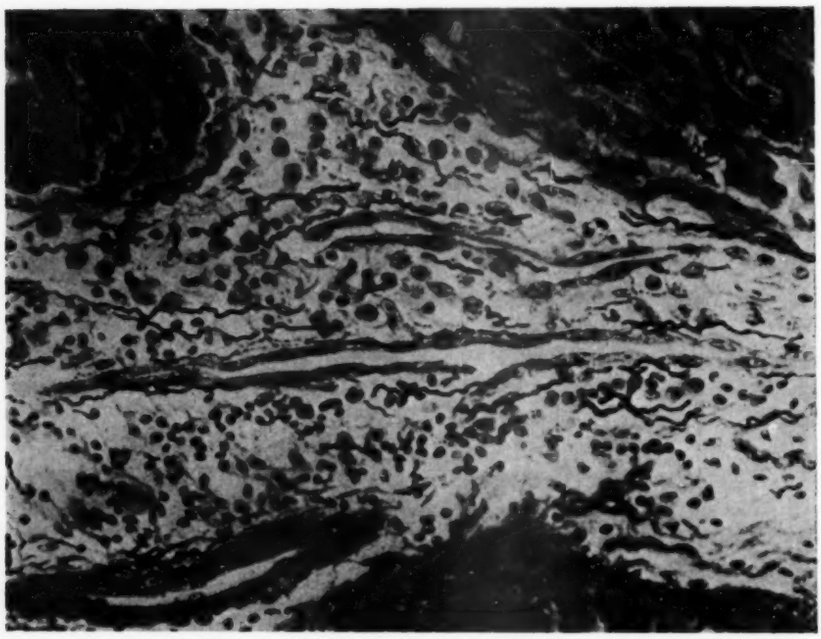

FIG. 1. Non-myelinated nerve fibers around the blood vessels at the periphery of a seven months' cicatrix. There are also mononuclear cells in close relation to the vessels and others between the strands of collagen (Howes). (Courtesy of: LERICHE, R. The Surgery of Pain, p. 412. Baltimore, Md., 1939. Williams & Wilkins Co.)

so that the injection must be made progressively closer to the spinal cord and finally even paravertebral injection of the spinal nerve may not be effective. In an operative area compression pain frequently occurs after herniorrhaphy, when the ilio-inguinal and ilio-hypogastric nerves, and the genitofemoral nerve may be involved.

Compression of a nerve which gives rise to pain may be due to hemorrhage, blood extravasation, etc., which may occur under deep fascia. Pressure on a nerve may also occur when the nerve is superficial to the fascia. Parkes[9] reported a localized hemorrhage in the tissue due to hemophilia, which produced symptoms of nerve involvement. Acute inflammation of the tissues may also cause pressure of sufficient intensity to compress a nerve. In some instances a small enlargement similar to a neuroma may be present at the end of the involved nerve.

In this respect painful scars have a close resemblance to causalgia, which occurs in the limb in which there is injury to the sympathetic nerves. The pain is particularly similar in that it is indefinite and irregular in distribution and does not remain constant in one area. It is also of the burning type, characteristic of sympathetic nerve pain. The temperature of the scar tissue area in which pain is present is slightly reduced.

It may happen that painful scars occur in areas in which the superficial tissues and the skin do not show any apparent evidence of a previous injury of which there is a history. In these cases, although the superficial tissues were intact, there may have been injury to the deeper tissues, tendons, muscles, or fascia, with imperfect healing.

SYMPTOMS

After every incision, especially in the abdominal wall, there is tenderness and some pain which usually passes away in a few days but at other times a few months or even years may elapse. In some individuals, however, the pain persists and becomes worse and in others it is first noticed at a variable interval after healing of the wound. The epithelium over the scar may be so tender that the lightest touch is painful. Apparently the cases in which pain is present do not differ in the manner of healing from those in which pain is not present. Painful scars are more common where there is a small amount of superficial tissue, and the epidermis is in close contact with the fascia and muscle.

However, I have noticed scars are not as painful in adipose tissue. However in some scars a large skin cicatrix of a keloid type may develop. Pain or soreness frequently is present in these keloids which may be very large and deforming. Why keloids develop in some individuals and not in others is unknown.

The scar following an abdominal operative incision may be especially painful when weather conditions change. This pain is of minor importance and is usually disregarded by the patient, who considers it as a discomfort, necessary to be borne after an operation or injury. In some cases pain is very severe and is associated with motor symptoms, especially if the scar is on a limb; often muscular atrophy of the affected limb occurs. Pain may be of a burning type and usually is definitely located in the scar tissue. The skin adjacent to the scar may become hypersensitive so that in the neighborhood of large scars hypersensory reactions occur when contact is made with any object. At times the adjacent tissue pain is very intense but usually is only unpleasant and annoying, and borders on the sensation of pain. Pain may be referred to an area some little distance from the scar. It can be so severe that the individual resents the pressure of clothing upon the affected area, especially pressure of a belt over the scar in the lower abdomen due to an appendicitis operation.

In many instances pressure by the examiner's hand is very painful and the pain may be limited to a small area on which the pressure causes not only local pain, but also pain referred in the areas of distribution of the effected nerve such as in the ilio-inguinal and ilio-hypogastric nerve. In a case reported by Gordon and Carleton[3] the "ilio-hypogastric nerve was caught in the scar of a kidney operative incision and pain was referred over the lower right quadrant." The painful condition was cured by division of the ilio-hypogastric nerve. Differentiation of the pain referred from deep intra-abdominal structures is that voluntary contraction of the abdominal muscles will relieve the referred pain but will increase pain of the scar tissue.

The type of lesion that gives most concern is the incisional scar in which there is severe pain. The pain is directly in the scar and sometimes it is lateral to, or above or below the scar, or at a distance from the scar. Examination will frequently disclose a tender thickening of the area closely adjacent to the scar, and in this area of thickening there is a tender spot. Pressure upon it may produce pain radiating to or away from the scar.

When a painful nodule or tumor growth in scar tissue becomes larger and more painful during menstruation, the probable relation to an endometriosis may be suggested.

In some instances there may not be any apparent causative factor;[10] but frequently an induration of the tissues adjacent to the incision has been noted following an operation, and this can conceivably cause pressure on the incorporated nerves.

Pain may also be aroused by pull and drag by muscle tissues incorporated in the scar, so that movement of the affected part with shifting of the tissue layers (especially when the scar is in the abdominal wall) may also cause traction and drag upon the scar tissues with the production of pain. This may occur in deep inspiration when the tissues of the skin and subjacent tissues are stretched during the act of respiration.

Warmth or heat does not influence the pain. If the pilomotor reflex is very active, it indicates a possible relation to sympathetic terminal nerve irritability with vasodilatation, edema and exudation with pressure on nerve terminals.[7] Associated with a superficial cicatrix are other effects such as occur from involvement of sympathetic nerve fibers, reflex muscular contractions, especially of unstriated muscle and stimulation of related sebaceous glands (sweat glands). The striated muscle may be affected and contraction of the involved muscle occurs as is noticed in the abdominal wall, in the area of the scar. This contraction is particularly prominent in the extremities where painful scars may result in spastic conditions of the limb. If the spastic reaction of the arteries occurs, the vasospasm causes pallor, insufficient tissue nourishment and atrophy of the skin. In the extremities the nails and subcutaneous tissues are atrophied.

Scar tissue may occur in internal organs and may cause pain by contraction or adhesive formations during: (1) normal functional activity of an organ which contains excessive amounts of connective tissue; (2) normal distention of an organ resisted by a thickened capsule; or (3) restriction of the mobility of an organ. The best example of the first condition is cirrhosis of the ovary.

As a rule connective tissue infiltration of an

organ does not call for the removal of the diseased organ, unless the lesion interferes with normal functional activity as in the bowel or stomach. The treatment of other connective tissue infiltrates is nonsurgical.

DIAGNOSIS

In many cases of painful scar the possibility should be considered that the pain may not originate in superficial lesions but is referred to the skin from intra-abdominal lesions. In these instances the pain is less constant and when due to intestinal adhesions is more paroxysmal due to peristaltic bowel drag of the adhesions. Palpation and pressure on the abdomen, both over the scar and at a distance from it, will cause pain in the adherent area. At times the pain is accompanied with a nauseous, sick feeling.

Referred pain from diseased viscera causing pain referred to the abdominal wall is present in the dermatomic areas in which the scar, by chance, is located, and is incorrectly thought to be the cause of the pain in the superficial skin over the scar, or in the immediate neighborhood of the scar. This pain is frequently associated with sweating and a lowered skin temperature in the particular area affected.

In the diagnosis it is also well to exclude the possibility that a nodule of fat, omentum or bowel may have pushed through an intra-abdominal or abdominal wall hernia resulting from operation. Nodular fat masses in the subcutaneous tissue may be a cause of pain.

In psychoneurotic individuals attention may be focussed upon and localized in the scar, and patterns of pain and distress be created in the area of the scar.[5]

TREATMENT

Local application of anesthetic ointment and solutions are unsuccessful, but pain may be relieved by temporarily blocking the involved nerve or nerves by an injection of procaine, or other analgesic solutions, or 95 per cent ethyl alcohol into the immediate neighborhood of the affected nerve fibers. If this is unsuccessful, circumferential deep injection of a longer lasting anesthetic, thiodacaine or quinocaine, efocaine trithesia etc., in considerable quantities may be required. Circumferential block may be necessary.[1]

If injection treatment is unsuccessful, the scar should be excised.[4] Any exposed nerve fibers should be extracted. In resuturing very careful approximation should be made. An auto-plastic graft may be inserted if the area of cicatrization is large.

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Modern Operative Technics

No. 14

RECURRENT DISLOCATION OF THE SHOULDER*

TOUFICK NICOLA, M.D.
Montclair, New Jersey

FROM a review of the literature and from my own observations I am convinced that the pathology of recurrent dislocations of the shoulder is not the same in all cases. Therefore, if the surgeon is to approach this subject realistically, he should choose an operation depending upon the pathologic condition which he finds at the time of operation.

I observed the following pathologic changes in twenty-five consecutive cases of recurrent dislocation of the shoulder:

In sixteen cases the capsule and labrum were detached in varying degrees from the anterior margin of the glenoid cavity (Bankart). In all of these cases the capsular cavity was enlarged because the anterior capsule had been ruptured (Gerster, Hybbinette). In eleven of these sixteen cases a defect was found in the head of the humerus at the posterolateral portion. The size of the defect depended on the length and frequency of recurrences, e.g., the older the case, the larger the defect. This defect may be seen preoperatively by an x-ray of the shoulder joint when it is in extreme internal rotation.

In nine cases the capsular cavity was enlarged due to the rupture of the anterior capsule. *The labrum was not detached from the anterior margin of the glenoid.*

In two cases the anterior rim of the glenoid cavity was depressed. The posterolateral defect was found in both of these cases. There was also partial detachment of the capsule and labrum from the anterior margin of the glenoid cavity, as well as an enlarged capsular cavity.

SUMMARY OF PATHOLOGIC FINDINGS

Detachment of the labrum and capsule	16
Enlarged capsular cavity	25
Defect in the posterolateral aspect of the head of the humerus	19
Depression of the anterior rim of the glenoid	2

From these pathologic findings it is seen that you cannot depend on only *one* operative procedure to obtain the best results. Therefore you must determine the pathologic condition which is present and try to correct it.

TECHNIC

The following is our approach to the operative treatment of recurrent dislocation of the shoulder:

The first part of the operation consists of exposing the pathologic disorder present.

1. An incision should be made over the anterior aspect of the shoulder beginning just medial to the coracoid process and extending downward for about 5 inches following the curve of the deltoid muscle. (Fig. 1.)

2. Locate the interval between the deltoid and pectoralis major muscles and retract the deltoid muscle laterally. (Fig. 2.)

3. Divide the tendons (conjoined) of the short head of the biceps and the coracobrachialis ½ inch from the coracoid process. (Fig. 3.) This allows for easier resuturing of the tendons. Place a stay suture through the tendon and reflect it downward. In this step do not overstretch the musculocutaneous nerve which pierces the coracobrachialis muscle and then passes obliquely between the biceps brachii and the brachialis to the lateral side of the arm.

4. Rotate the arm outward to identify the lower border of the subscapularis tendon. Along the lower border of the tendon of this muscle you will see a small plexus of veins which accompanies the anterior humeral circumflex artery. Ligate these veins carefully. (Fig. 3.)

5. Pass a long curved clamp from below up-

* From the Department of Orthopaedic Surgery, Mountainside Hospital, Montclair, and the Hospital and Home for Cripped Children, Newark, N. J.

ward between the capsule and the tendon of the subscapularis. Secure the medial portion of the tendon with two strong silk sutures, one at the upper and one at the lower border of the tendon.

incision mid-way between the lateral cut end of the subscapularis tendon and the anterior margin of the glenoid cavity which can be felt through the capsule. (Fig. 4.)

8. Explore the joint cavity; suction will help

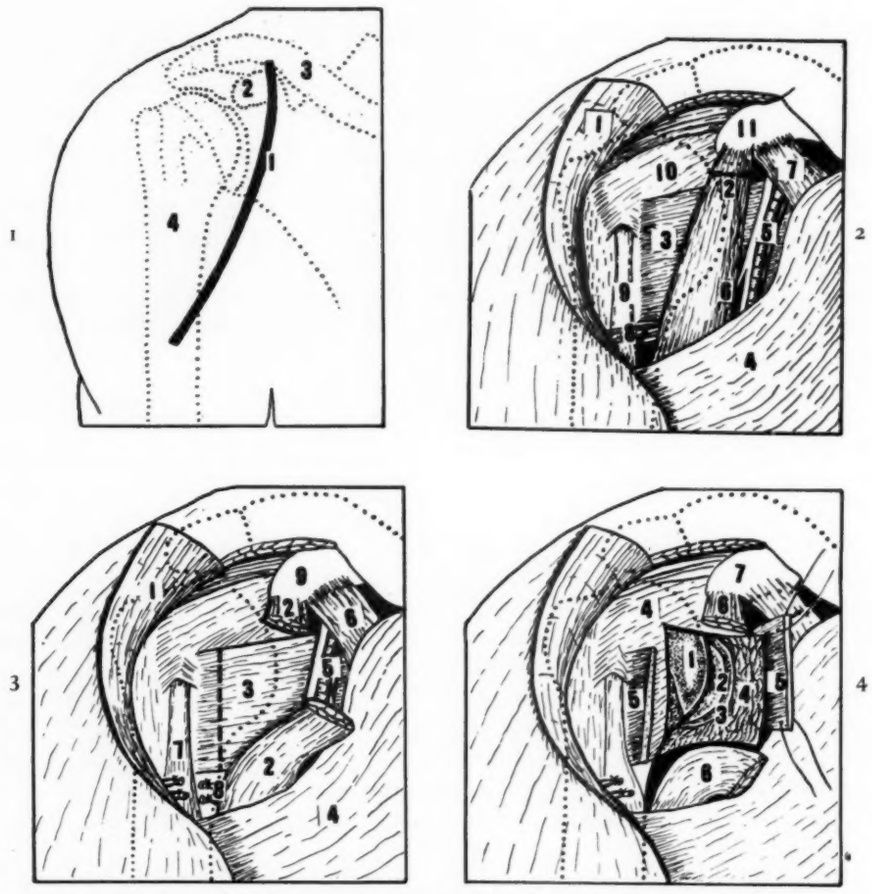


FIG. 1. (1) Line of incision; (2) tip of coracoid process; (3) clavicle; (4) humerus.

FIG. 2. (1) Deltoid retracted laterally; (2) point of division of conjoined tendon; (3) subscapularis tendon; (4) pectoralis major; (5) neurovascular bundle; (6) point of entrance of the musculocutaneous nerve into the coracobrachialis muscle; (7) pectoralis minor tendon; (8) plexus of veins at lower border of subscapularis muscle; (9) long head of biceps; (10) anterior capsule; (11) tip of coracoid process.

FIG. 3. (1) Deltoid retracted laterally; (2) conjoined tendon cut; (3) subscapularis muscle; (4) pectoralis major; (5) neurovascular bundle; (6) pectoralis minor tendon; (7) long head of biceps; (8) plexus of veins, ligated and cut; (9) tip of coracoid process.

FIG. 4. (1) Head of humerus; (2) glenoid cavity; (3) labrum; (4) anterior capsule; (5) subscapularis cut; (6) conjoined tendon cut; (7) tip of coracoid process.

6. Divide the tendon of the subscapularis just lateral to the clamp and the stay sutures. Retract the muscle medially and expose the underlying capsule.

7. Open the capsule by making a transverse

to keep the wound clean. You will see the defect in the head of the humerus, if there is one, by abduction and external rotation. Medial retraction of the capsule will expose the rim of the glenoid and its disorder. Overlap the an-

terior capsule to demonstrate the enlarged capsular cavity.

At this stage of the procedure the operator, having determined the pathologic condition, will take steps to correct it.

2. Pull the capsule laterally over the head of the humerus. Retract the subscapularis medially. Feel for the edge of the glenoid and then, with two small staples or Delatata T-shaped nails, attach the capsule to the neck of the

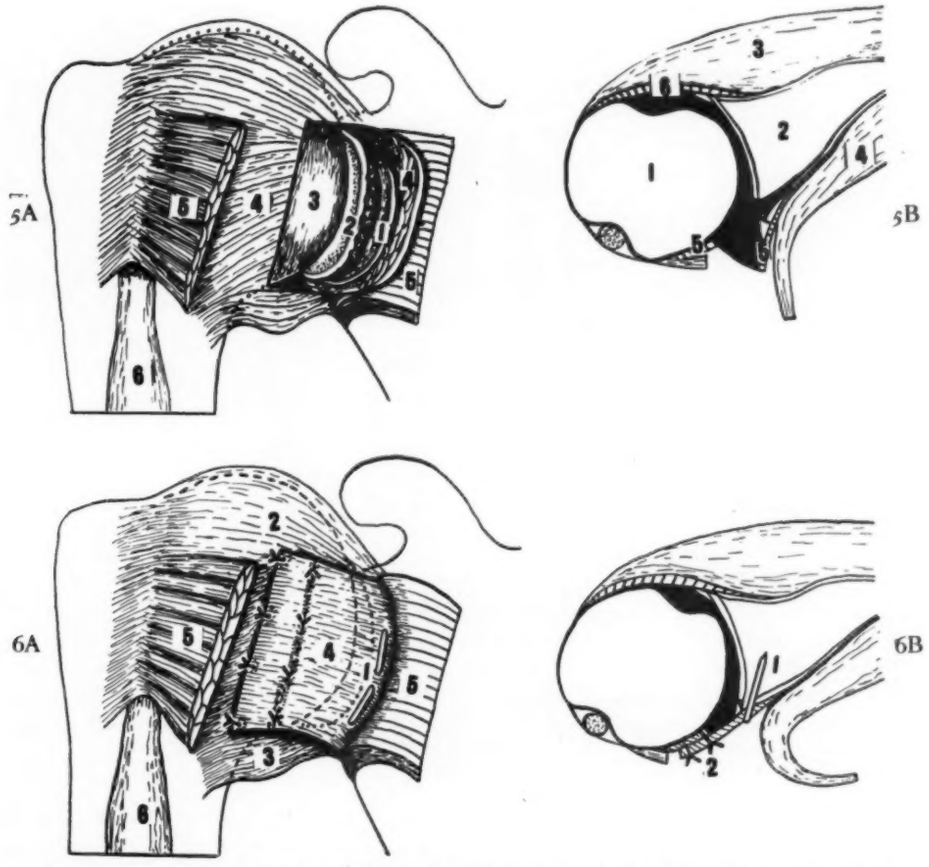


FIG. 5A. (1) Labrum separated from glenoid cavity; (2) glenoid cavity; (3) head of humerus; (4) anterior capsule; (5) subscapularis cut; (6) long head of biceps.

FIG. 5B. Horizontal section through shoulder. (1) Head of humerus; (2) scapula; (3) infraspinatus muscle; (4) subscapularis muscle; (5) anterior capsule and subscapularis cut.

FIG. 6A. (1) Staples through anterior capsule and edge of glenoid cavity; (2 and 3) anterior capsule; (4) anterior capsule overlapped; (5) subscapularis cut; (6) long head of biceps.

FIG. 6B. Horizontal section through shoulder. (1) Position of staple through anterior capsule and rim of glenoid cavity; (2) anterior capsule overlapped.

If the capsule and the labrum have been detached from the rim of the glenoid and the capsular cavity is enlarged (Fig. 5A and B) reattach the capsule to the rim (Bankart) and make the capsular cavity smaller by overlapping the anterior capsule.

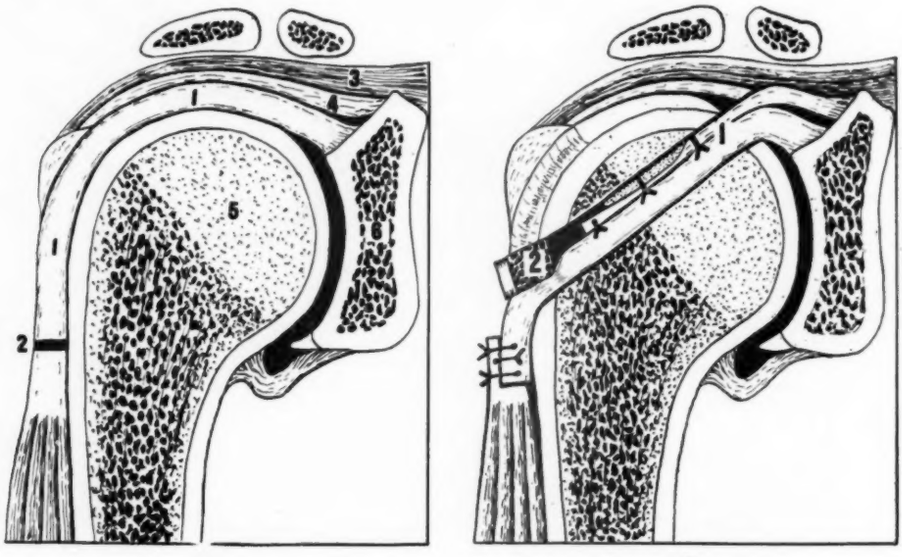
1. Scarify the anterior rim and neck of the scapula with a sharp osteotome.

scapula just below the rim of the glenoid. (Fig. 6A and B.)

The use of staples or Delatata T-shaped nails simplifies the operation. We find that the use of sutures to attach the capsule to the edge of the glenoid is a very difficult procedure in spite of what some authors claim.

3. Pass the long head of the biceps and

½ inch of the coracohumeral ligament through the head of the humerus. The hole should come out at least ½ inch from the rim of the articular surface of the head of the humerus. We suture these to the distal end of the long head of the biceps tendon because we believe that this step minimizes the chances of recurrence. (Figs. 7 and 8.)



7 8

FIG. 7. Coronal section through shoulder. (1) Long head of biceps; (2) point of division of long head of biceps; (3) supraspinatus; (4) coracohumeral ligament; (5) head of humerus; (6) scapula.

FIG. 8. Coronal section through shoulder. (1) Long head of biceps and coracohumeral ligament passed through head of humerus; (2) plug of bone which was removed from head of humerus placed at distal end of the tunnel to fix long head of biceps.

4. Resuture the subscapularis tendon and reattach the short head of the biceps and coracobrachialis muscles.

5. Bring the deltoid and pectoralis major muscles together with a few interrupted chromic No. 00 sutures.

6. Suture the subcutaneous fascia and skin with continuous subcuticular fine braided stainless steel sutures. Do not remove these because they will prevent marked spreading of the scar.

7. Apply a Velpeau bandage and keep it on for two weeks. Then support the extremity in a sling for four weeks more. During this latter period the patient may use his hand and elbow. Elevation of the hand above the head should not be permitted for at least eight weeks from the time of operation.

If only the capsular cavity is enlarged, due to a rupture of the anterior capsule (Fig. 9A and B), the anterior capsule should be overlapped (Gerster, Putti-Platt).

1. Draw out the medial portion of the capsule and overlap the tendon of the subscapularis giving a "double-breasted coat" effect. (Fig. 10A and B.)

2. Pass the long head of the biceps and ½ inch of the coracohumeral ligament through the head of the humerus and suture them to the distal cut end of the long head of the biceps. (Figs. 7 and 8.)

3. Suture the medial portion of the subscapularis muscle to the scarified rotator cuff which overlies the greater tuberosity. This step may be facilitated by the use of small staples or short Delatata T-shaped nails.

During steps 1, 2 and 3 keep the arm in a neutral position. This will avoid a prolonged period of convalescence.

4. Reattach the conjoined tendon in place and bring the deltoid and pectoralis major muscles together with chromic No. 00 sutures.

5. Suture the subcutaneous fasica and skin with a fine continuous braided stainless wire. Do not remove this. It will prevent wide spreading of the scar.

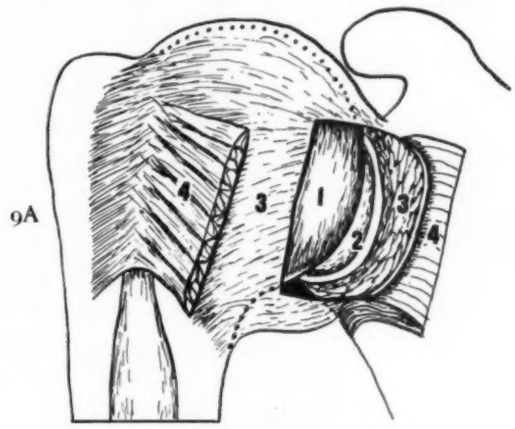
6. Bandage the arm to the trunk with a

Velpeau bandage. Keep it on for three weeks and then allow the patient to exercise the extremity.

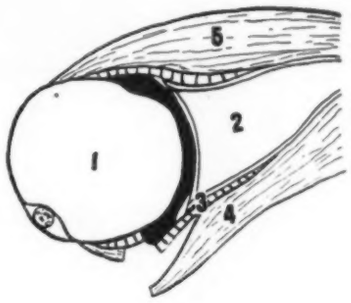
If you find the glenoid rim depressed or a large depression in the posterolateral aspect of the head of the humerus ((Figures 11A and B), make a pocket at the anterior margin of the articular surface of the glenoid with a sharp 1 inch osteotome.

1. Remove a bone graft 1½ inches long and about ¾ inch wide at the base tapered to ½ inch from the inner concave surface of the ilium.

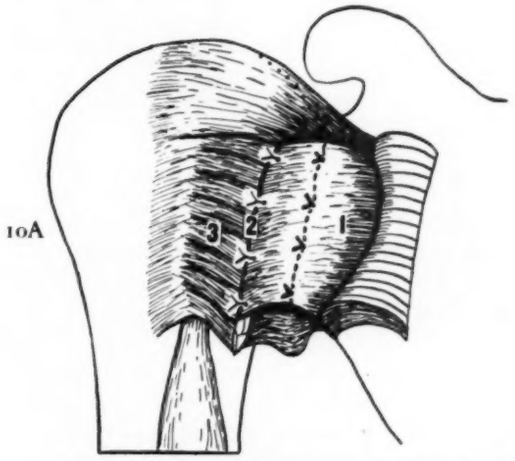
2. Push the bone graft down into the pocket and impact it firmly. The graft should not stick up more than ½ inch. If the graft does not feel firm, secure it with one Delatata T-shaped nail passed from outside through the capsule, then through the graft into the neck of the scapula. (Fig. 12A and B.)



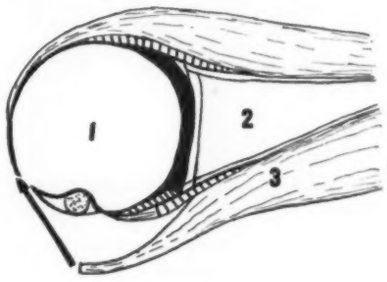
9A



9B



10A



10B

FIG. 9A. (1) Head of humerus; (2) glenoid with attached labrum; (3) anterior capsule; (4) subscapularis cut.

FIG. 9B. Horizontal section through shoulder. (1) Head of humerus; (2) scapula; (3) anterior capsule and labrum attached to glenoid; (4) subscapularis muscle; (5) infraspinatus muscle.

FIG. 10A. (1) Anterior capsule; (2) line of suture of anterior capsule to the cut subscapularis muscle; (3) subscapularis muscle.

FIG. 10B. Horizontal section through shoulder. (1) Head of humerus; (2) scapula; (3) subscapularis muscle.

3. Pass the long head of the biceps and ½ inch of the coracohumeral ligament through the head of the humerus.

4. Resuture the capsule, subscapularis and conjoined tendons. Bring the deltoid and pectoralis major muscles together with chromic No. 00 sutures.

5. Close the subcutaneous fascia and skin

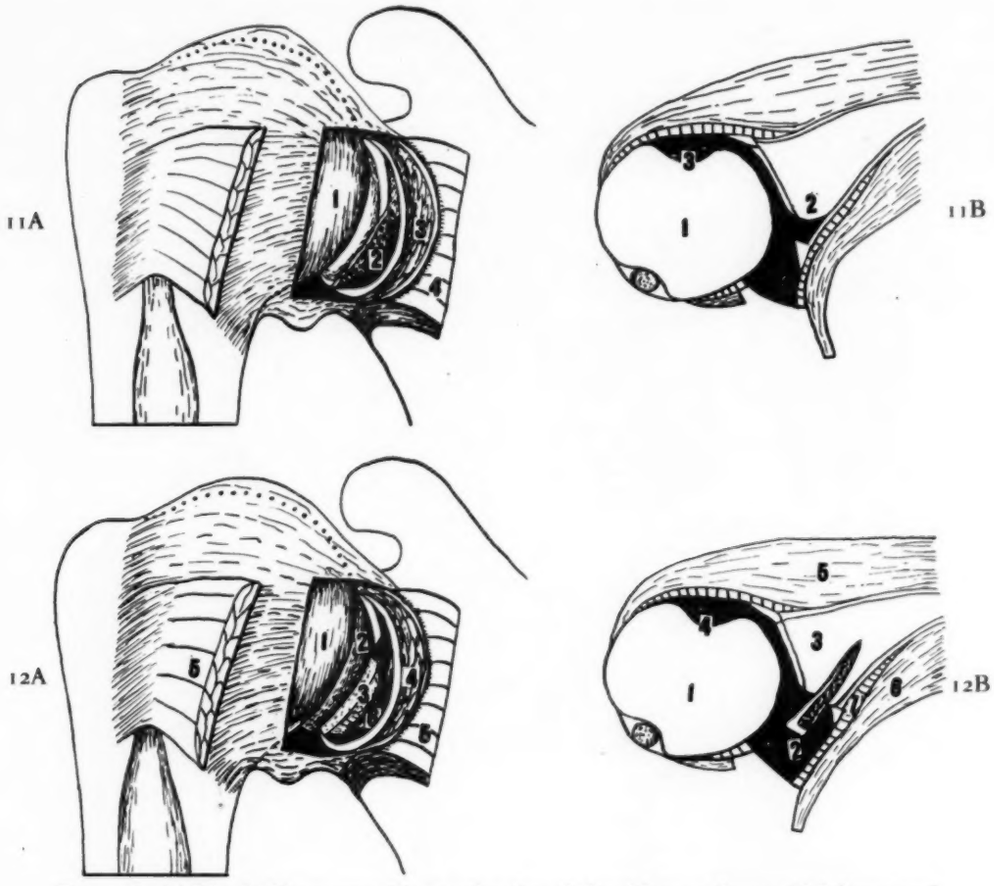


FIG. 11A. (1) Head of humerus; (2) anterior rim of glenoid worn down; (3) labrum and capsule separated from rim of glenoid; (4) subscapularis muscle.

FIG. 11B. Horizontal section through shoulder. (1) Head of humerus; (2) anterior rim of glenoid worn down; (3) notch in posterolateral aspect of head of humerus.

FIG. 12A. (1) Head of humerus; (2) glenoid; (3) bone graft from inner side of pelvis in place; (4) anterior capsule and labrum separated; (5) subscapularis muscle.

FIG. 12B. Horizontal diagram through shoulder. (1) Head of humerus; (2) bone graft in place at anterior rim of glenoid; (3) scapula; (4) notch in posterolateral aspect of head of humerus; (5) infraspinatus muscle; (6) subscapularis muscle; (7) anterior capsule.

with one continuous subcuticular suture. This will help to prevent marked spreading of the scar.

6. Immobilize the arm for six weeks with a Velpeau bandage changed every few weeks. Then prescribe gradual exercise.

CONCLUSION

The pathology of recurrent dislocation of the shoulder is not the same in all cases. Therefore the operative treatment of recurrent dislocation of the shoulder should depend upon the pathologic disorder present.

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Even when no lesion can yet be seen in the cervix uteri by the naked eye, preinvasive squamous carcinoma can be detected by cervical cytology taken routinely by scraping the surface of the cervix. Such a localized lesion can be completely excised by deep conization of the cervix. Often the pathologist can be sure, by examination of this conized specimen, that the localized lesion was actually removed *in toto*. If it was, after healing follow-up cervical scrapings and other cytologic tests will persistently prove negative. (*Richard A. Leonardo, M.D.*)

Streamlined Articles

WET SUSPENSION STAINING METHOD FOR RAPID EXAMINATION OF EXFOLIATED CELLS AND PARASITES FROM VAGINA AND INTESTINE

LEONARD R. THOMPSON, M.D.
San Pedro, California

THE Papanicolaou stain is too complicated and expensive for routine use in vaginal examinations made in the office. Described herein is an exceedingly simple and rapid wet suspension staining technic for exfoliated cells and for material obtained by scraping or curetting.

The procedure is useful in diagnosing infections due to trichomonas and monilia, estrogen level and cancer. The method has advantages over smear technics, namely, superior cell dispersion and lack of cell distortion. It is also useful in detecting parasites in stool examinations.

* * * *

The Papanicolaou stain is not being done routinely because the method requires too much time and expense. This was emphasized in the discussion of a paper on the vaginal smear presented by Rosenthal[1] at the meeting of the California Medical Association. In two hospitals where the Papanicolaou stain is available the writer has heard of cancer of the cervix being cut through during hysterectomy for fibroids, no Papanicolaou stain having been done.

It would be a physical impossibility for trained cytologists to examine Papanicolaou stains for all women who have vaginal examinations. Therefore, it is highly important to make available a technic for examination of exfoliated cells which is so easy that it can be made routine in any general practitioner's office.

I have used the simple, rapid technic described herein and my records show that more than 400 patients were examined before cancer was detected. This indicates that routine Papanicolaou staining is a waste of time and money if a simple substitute or screening method is available.

The procedures described offer rewards which invite the examiner to make routine cytologic examinations.

TECHNIC

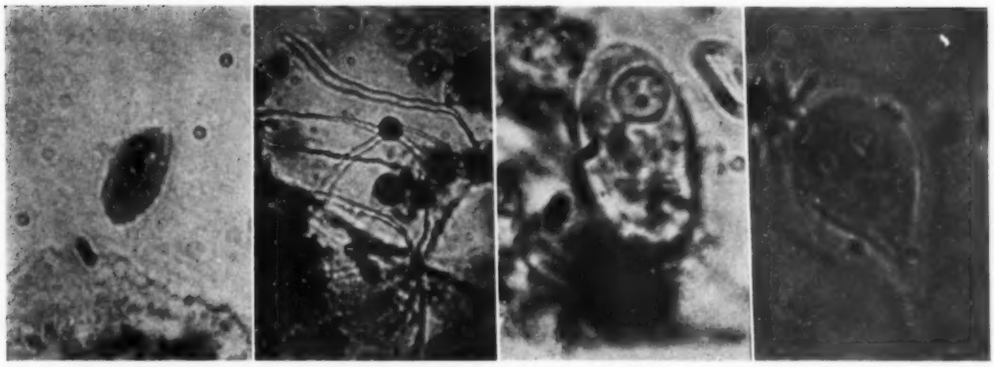
Crystal violet or gentian violet, as used in the Gram stain and found on any bacteriologist's shelf, is used in ¼ per cent strength. Equipment: normal saline in a dropper bottle, slides, toothpicks, long cover glasses, a good microscope and Hurd's tonsil dissector or tongue blade.

The cell suspension is obtained in the following way: A drop of normal saline is placed on the center of a slide. The vaginal speculum is introduced dry or lubricated with normal saline. The loose cellular material posterior to the cervix is picked up on Hurd's tonsil dissector or a tongue blade and is mixed with the saline on the slide. If desired the material which collects on the posterior blade of the speculum may be used.

If the surface of the cervix shows an area suggestive of cancer, it is lightly scraped to get material. Three such slides are obtained. The first is covered with a cover glass and examined unstained for trichomonas in the manner usually advised.

On the second slide a small drop of gentian violet is thoroughly mixed with the cell suspension by means of a toothpick and then covered by a long cover glass. If the drops are not too large, the weight of the cover glass will thin the mixture so that the stain will not be noticeable except in the cells to be studied. This slide is then ready for immediate examination.

If the patient is bleeding, the bloody discharge is mixed in a centrifuge tube with 10



1A 1B 1C 1D

FIG. 1. Parasites, gentian violet stain. A, trichomonas; B, monilia; C, Endamoeba histolytica; D, Giardia lamblia.

per cent acetic acid solution. After lysis is complete, the mixture is centrifuged and the sediment is transferred by a medicine dropper to a slide and stained with gentian violet as described previously.

With the cell suspension on the third slide a drop of Lugol's solution is thoroughly mixed. The slide is then observed for glycogen without the microscope. If pus or red cells are present, a cover glass is used and the slide is examined under the low power of the microscope.

RESULTS

Trichomonas. This was found in over 10 per cent of the slides. If the patient has not recently douched or been exposed to a chemical such as is found in a lubricant or suppository, the trichomonads are motile and therefore easily detected. Under a dark field microscope they are spectacular. If they are immotile due to lubricating jelly, they may be identified by their shape which may be round or like a lemon or pear; by their size, which is a little larger than a pus cell; and by the finely granular appearance of the cytoplasm. When stained they may show a small nucleus. (Fig. 1A.) In a deeply stained slide flagella may be visible. Usually they remain unstained.

Monilia. This occurs in masses of curd-like material sticking to the vaginal wall and is accompanied by a profuse discharge. The curdy material is placed on a slide and macerated with a toothpick. After addition of gentian violet the filaments are found projecting from masses of stained epithelial and pus cells. (Fig. 1B.)

Estrogen Level. To diagnose estrogen level one notes the amount of material on the spatula that picked up the vaginal collection. In the atrophic old vagina the material is scant and the mucosa may bleed easily.

To identify a low estrogen level the examiner should look for immature cells, which are classified in Papanicolaou and Traut's book.[2] They are visible in the unstained suspension but are easier to see in the gentian violet preparation. They may be large oval cells with medium-sized nuclei (Figs. 2B, 3A, 3B and 3D) or they may be small and oval, or round, with larger nuclei. Occasionally the cytoplasm has points or tails.

The cytoplasm of small basal cells stains more deeply than that of superficial cells. (Fig. 3D.) Basal cells may appear in clumps (Fig. 3B), sheets or chains (Fig. 2B). Nuclei are spaced with regularity in the clumps because of relatively standardized cytoplasm volume. They are also uniform in size and shape. The navicular and outer basal type cells take the stain less intensely, thereby indicating the retention of moisture and vitality.

Mature cells are large, flattened and irregularly polygonal, with small pyknotic nuclei. (Fig. 2A.) Pus cells are numerous in menopause suspensions. (Fig. 2C.) If the patient is given estrogens, re-examination in ten days may show disappearance of pus cells and basal cells.

Radium may produce bizarre changes which respond more slowly to estrogens. The cells may mimic cancer. (Fig. 4.)

Glycogen. A drop of Lugol's solution is added to a drop of the saline suspension on the third slide and observed without the microscope.

When the patient has been treated with estrogen, the suspension is rich in glycogen and the slide turns black with clumps of

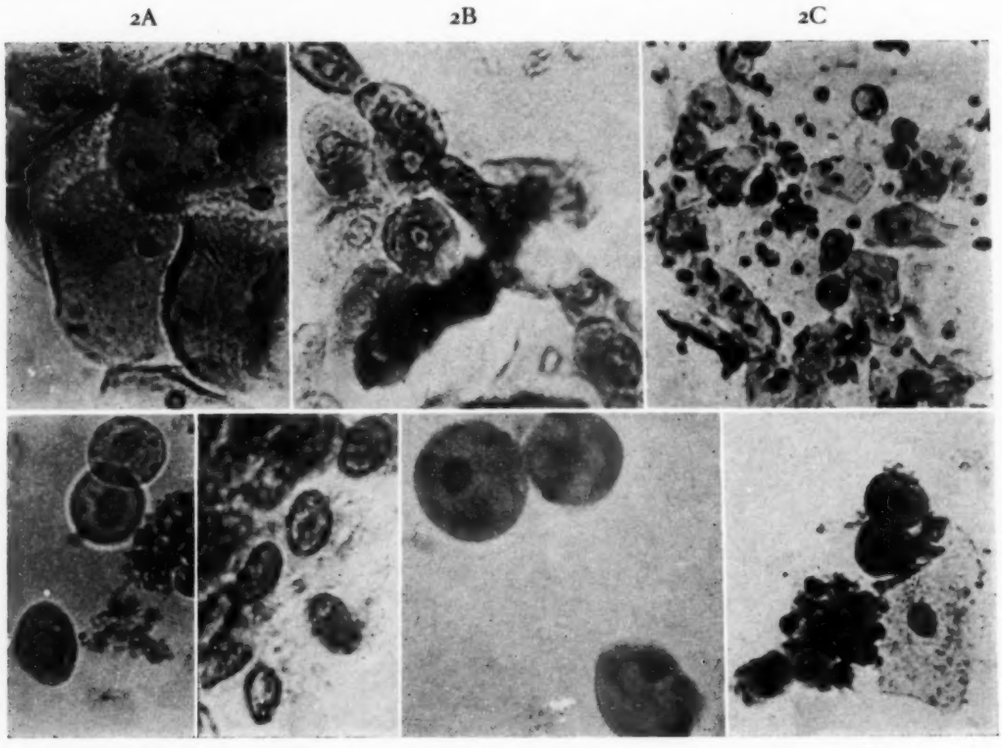


FIG. 2. Non-malignant cells, gentian violet stain. A, superficial type, mature cells; B, basal cells in chains; C, low power view of menopause suspension, mixed types of cells.

FIG. 3. Non-malignant cells, gentian violet stain. A and B, basal cells; C, histiocytes; D, basal cells, pus cells and near mature cell.

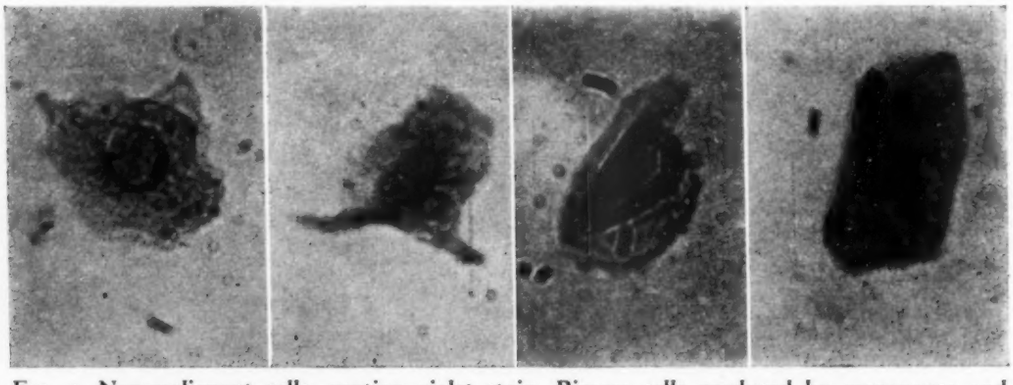


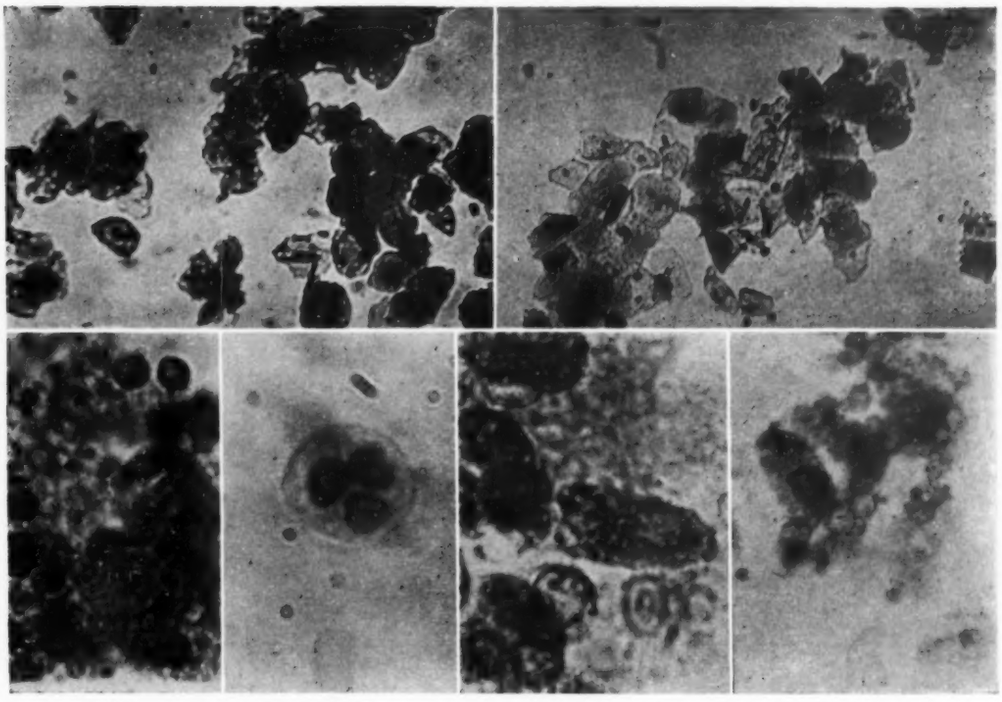
FIG. 4. Non-malignant cells, gentian violet stain. Bizarre cells produced by menopause and radiation.

stained cells. The slide from an estrogen-poor patient shows very little color change. That from the average normal patient shows a moderate amount of brownish stained particles. (Fig. 5.)

The preparation is then examined under the microscope, as red cells and pus cells may take enough of the iodine stain to be confusing.

This technic is similar in results to that described by Mack.[3] Glycogen is graded as follows by the writer: 1+ = very little, almost none; 2+ = moderate amount; 3+ = normal; 4+ = large amount, seen in estrogen-treated persons and occasionally in a young normal woman.

Pus cells may suggest menopause, cancer, inflammation, trichomonas, monilia or erosion. When stained with gentian violet they show deeply colored nuclei which are rounded into little balls in a clear cytoplasm. (Fig. 6B.)



5A 5B

6A 6B 6C 6D

FIG. 5. Cells stained with Lugol's solution. A, normal amount of glycogen; B, moderate amount of glycogen.

FIG. 6. Non-malignant cells, gentian violet stain. A, scrapings from endometrium; B, polymorphonuclear cell; C, columnar cells; D, cell from placental tissue with red cell shadows.

They are predominantly polymorphonuclear. Histiocytes are distinctively stained. (Fig. 3C.)

Red Cells. The causes of vaginal bleeding will not be enumerated here, but it is important to know that the majority of cancers are accompanied by macroscopic or microscopic bleeding.[2]

Endometrial Cells. Endometrial cells are occasionally found. The nuclei may be of different sizes, in this respect resembling cancer of the endometrium. Curettings may be stained by this method but require a trained observer to read them correctly. (Fig. 6A.) Columnar cells viewed end on may be hard to identify. (Fig. 6C.)

Langbans' Cells. If a patient passes what appears to be a blood clot, a portion of it may be macerated and stained. A spindle-shaped or elongated cell with a large oval nucleus, which has a distinctive appearance with the gentian violet stain, suggests the presence of placental tissue. (Fig. 6D.)

The suspension is of no aid in early diagnosis of pregnancy except in a patient who misses a period while in her forties. Immature cells may then indicate menopause and are strong evidence against the diagnosis of pregnancy.

*Cancer Cells.** Cancer cells when stained by this method are recognized by the criteria described by Papanicolaou and Traut[2] and by the Vincent Memorial Laboratory Staff.[4] If a clump of tissue is found, it should be teased apart by two needles and stained. In cancer clumps the cytoplasm is ill defined. Because of lack of standardization of cytoplasm the nuclei are unevenly spaced. They are of various sizes and shapes, are apt to be irregularly stained and lack polarity. (Figs. 7 and 8.)

The majority of slides will be unquestionably benign. The beginner will find that about half of the slides will show only normal superficial type cells. Pus cells will be easily recognized. Immature normal cells will be common and he can soon recognize them, although when they are in clumps he may suspect cancer. When he

* I am indebted to Dr. Grant Beckstrand, of Long Beach, Calif., for furnishing cancer material which aided in the development of this technic.

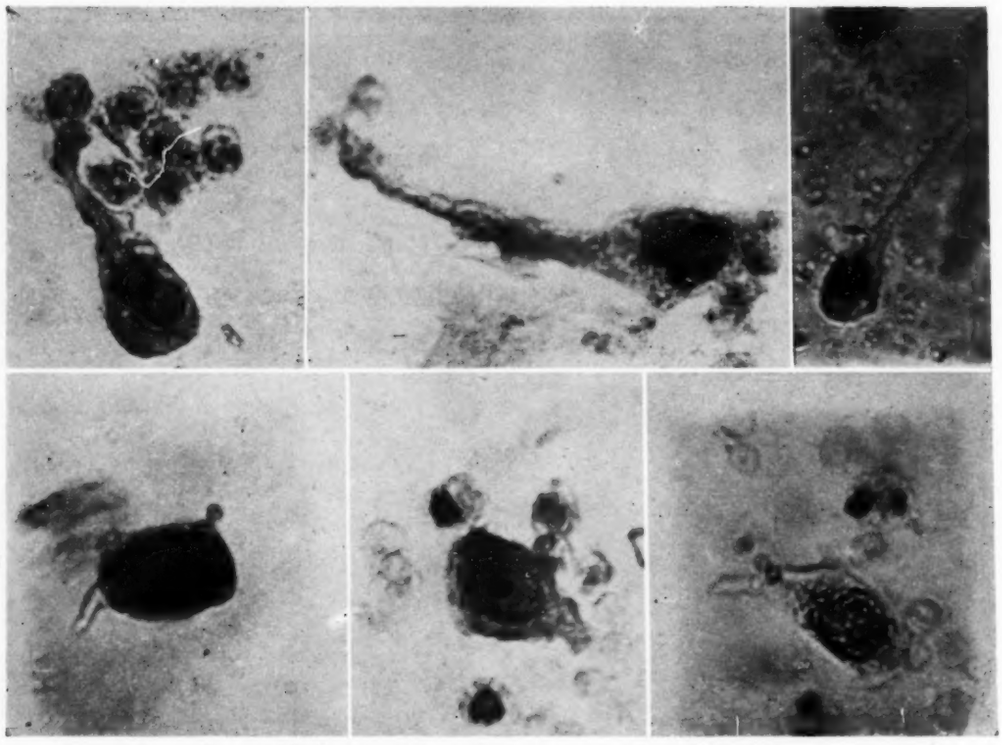


FIG. 7. Malignant cells, tadpole type, gentian violet stain.

FIG. 8. Malignant cells, gentian violet stain.

sees cancer cells, he will realize the need for consultation. As his experience increases, his need for consultation with the expert will decrease.

Any slide which shows pus or red cells should be examined with special care. The examination is started at one end of the cover glass and carried to the other. A preliminary survey is made with the low power; careful examination with the high dry power follows. At least twenty minutes should be devoted to suspensions which arouse suspicion of cancer. Repeat examinations should be made on different days. Infrequently an unexpected dividend is received by finding an ameba or noting sickle cells. Finding sperm cells may be of interest.

Disadvantages as Compared to the Papanicolaou Method. (1) The Papanicolaou counterstain is used to aid in distinguishing between different types of malignant and non-malignant cells. Its absence in this stain will be missed by those trained in the Papanicolaou technic. (2) Color change with estrogen deficiency is not seen; cyclic changes are not diagnosed. (3) Permanent slides are not made, but for a permanent record photomicrographs or sketches may be used.

To preserve for later study, a slide with a stained suspension can be put in a petri dish on top of a piece of wet blotter, and placed in a refrigerator where it will keep satisfactorily for at least twenty-four hours. The suspension in the centrifuge tube may be refrigerated.

Advantages as Compared to the Papanicolaou Method. (1) The method is immediately available to anyone who owns a good microscope. (2) Staining takes only a few seconds. (3) Clumps can be studied by focusing on individual cells in the clump. (4) Cell dispersion in the slide is superior because of mixing with a toothpick and the pressure of the cover glass. Thus a vast number of cells can be scanned in a short time. (5) Cells are not distorted by smearing. (6) Three dimensionality is maintained. (7) There is a minimum of change due to chemicals, as indicated by the fact that the trichomonas retains its motility when stained with ¼ per cent gentian violet without the addition of 10 per cent acetic acid. Hence we can be sure the cell bodies and nuclei are not distorted by the drying effect of alcohol and ether, or by distilled water and xylol as used in the Papanicolaou technic. Therefore, cellular

diagnosis is not confused by deformative changes produced by chemicals and drying.

USE OF THE METHOD IN OTHER FIELDS

Gentian violet with acetic acid staining is quite useful in stool examinations. The amorphous debris is deeply colored, affording a contrast to the delicate delineation of the parasite. Endamoeba histolytica shows light staining of the nucleus with a well marked karyosome. (Fig. 1C.) Giardia lamblia trophozoites are easily recognized. (Fig. 1D.) Giardia cysts absorb very little gentian violet but take on a shiny appearance which makes them stand out in contrast to the surrounding debris.

Ascitic fluid has been stained in the same manner. I have not used the method enough in sputum examination and in other fields to make a report but believe it should be useful.

COMMENTS

This technic is proposed for use by the nonexpert to help select the patient who should be given special diagnostic attention by means of the curet, biopsy and consultation with those who are trained in the Papanicolaou technic. Any slide which shows clumps of cells with a heavy concentration of nuclei, or cells which cannot be definitely identified as benign, should be studied by the trained cytologist. Blood or pus cells must be explained as they are commonly associated with cancer.

The method is important as a preoperative procedure. If the vaginal suspension is clean, with normal superficial type cells and without pus, surgery involving the vagina should have less postoperative morbidity. This is particularly important when complete hysterectomy is to be performed. Therefore the patient whose vaginal cytologic study is abnormal should have careful estrogenic preparation as well as careful antiseptic preparation of the vagina at the time of operation.

If vaginal suspensions are examined preoperatively, there will be fewer times when the surgeon is disagreeably surprised to find that the hysterectomy for fibroids has cut through a cancerous cervix.

The vaginal cell suspension, as described herein, makes routine examinations rapid, easy and valuable. If he does these examinations frequently, the general practitioner or gynecologist should become experienced in cytology.

In the writer's opinion this method of cytologic examination should be taught to all medical students so that such examinations eventually will be routine in office practice.

The compensations provided in determining the presence of trichomonas and in estimating estrogen level will make the examination of the vaginal cell suspension essential for any practitioner who prides himself on giving good service. The ability to diagnose cancer will come with time, experience and the stimulus to study which the method will supply.

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Case Reports

FOLLICULAR LYMPHOBLASTOMA OF THE ILEUM

G. F. Wollgast, M.D., F. Robert Mizer, M.D. and John W. Haskin, M.D.
Denver, Colorado

GIANT follicular lymphoma belongs to the group of malignant lymphomas of which it is the least malignant. It is a

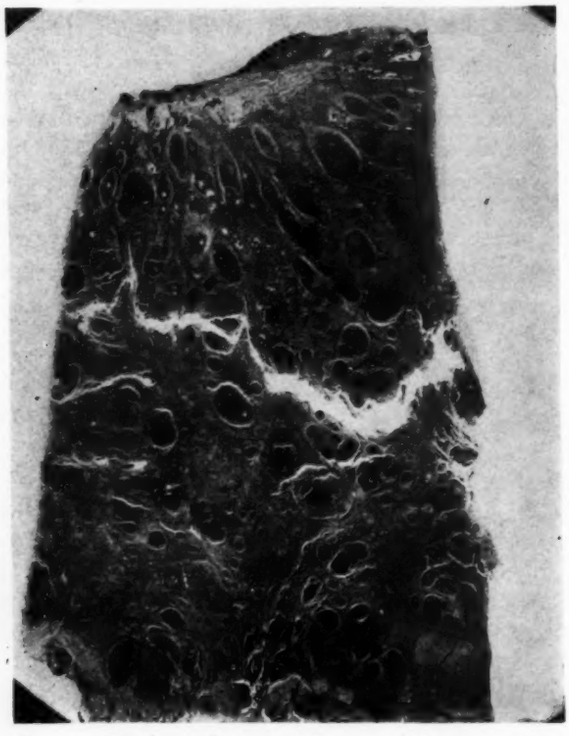

FIG. 1. Section of tumor demonstrating numerous enlarged lymph follicles.

systemic disease although there may be marked local manifestations. Histologically, there is a marked increase in the number and size of the lymph follicles, some of which occupy several low-power fields. (Fig. 1.) Reticulum cells are found in the center of the follicle, lymphoblasts beyond these and lymphocytes at the periphery. The interfollicular tissue is compressed.

Other names applied to this disease are: giant lymph follicle hyperplasia, malignant lymph follicle hyperplasia, follicular lymphoblastoma, giant follicular lymph adenopathy, follicular lymphadenoma, follicular lymphoma and Brill-Symmer's disease.

When involvement is limited to the small intestine, the symptoms are those of any small bowel tumor. There may be nausea, vomiting and cramping pain due to obstruction which may result from encroachment on the intestinal lumen or from intussusception. Pain may be dull in character and a movable mass may be the only finding. Hemorrhage can occur from ulceration of the mucosa. X-rays may reveal retention of barium in the small bowel. Small bowel studies may reveal a disturbance of the mucosal pattern but this is difficult to demonstrate. (Fig. 2.)

Brill, Baehr and Rosenthal[1] in 1925 first described this type of lymph follicle hyperplasia of the lymph nodes and spleen, collecting three cases from the literature and two of their own. Symmers[2] in 1927 describes a newly recognized disease, "follicular lymph adenopathy with splenomegaly." Karsner[3] reported a case in 1929. Baehr[4] in 1932 described the clinical and pathologic features of this disease distinguishing it from lymphosarcoma. In 1933 Rosenthal, Harris and Kean[5] discussed the excellent response to irradiation therapy. Involvement of the small bowel is rare as only two cases have been reported. Both involved the jejunum.

1. Cabot Case No. 25242[6]: The first admission of this patient was in 1939. Recurrent attacks had taken place one to three hours; there was dull abdominal pain during a period of eight months. Three weeks before admission pain became constant. Examination suggested a mass in the left abdomen. X-rays revealed an area of increased density in the region of the mass. The patient was discharged with a diagnosis of psychoneurosis. The second admission was seven years later. Gastrointestinal x-rays suggested a small bowel tumor and exploration confirmed the diagnosis. Pathologic

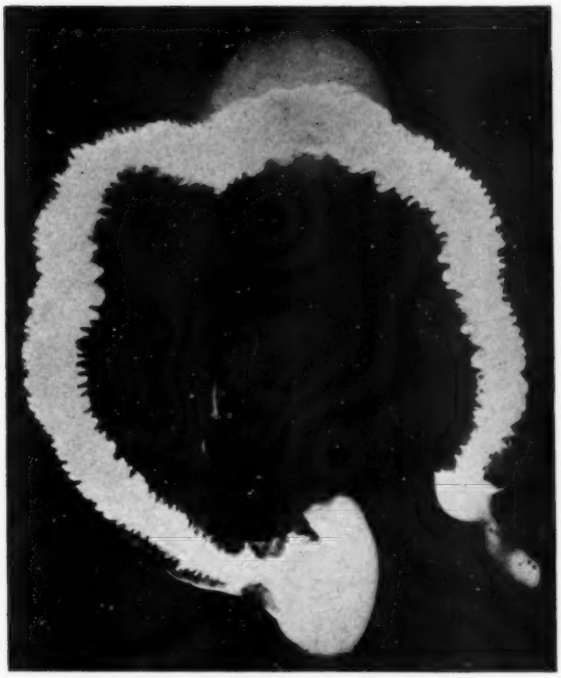

FIG. 2. Resected portion of intestine with tumor injected with barium to demonstrate the slight alteration of the mucosal pattern at the site of the tumor.

FIG. 3. Tumor of ileum and mesenteric lymph adenopathy.

report: giant follicular lymphoma of the jejunum.

2. Cabot Case No. 26041[7]: The patient, aged fifty-five, was admitted in January 1940. There had been intermittent digestive disturbance, for three to four years, with pain in the right upper abdomen relieved by vomiting and dull aching pain in the mid-abdomen. Examination revealed a large movable mass in the left mid-abdomen. Gallbladder x-rays revealed gallstones and intestinal x-rays demonstrated a dilated loop and barium retention in the small bowel. A preoperative diagnosis of lymphoma was made and confirmed at operation. Pathologic report: giant follicular lymphoma of the jejunum.

CASE REPORT

Mrs. G. P., age thirty-nine, was admitted on August 5, 1950. Symptoms included recurrent cramping abdominal pain and nausea and occasional vomiting over a period of five months. The most recent attack occurred one week prior to admission. The patient experienced no symptoms between attacks. Physical examination revealed that this patient had not lost weight. The only abnormal physical finding was a palpable mass on vaginal examination, above and to the left of the uterus. Gallbladder and gastrointestinal x-rays were reported as normal. There was no retention of barium in the small bowel and routine blood and urine examination were normal. A diagnosis of possible intestinal obstruction was made and operation was performed on August 6, 1950.

At operation a tumor of the ileum (Fig. 2) was found about 36 inches proximal to the ileocecal valve. In the mesentery immediately adjacent to the involved bowel were numerous enlarged lymph nodes. A biopsy and frozen section did not afford a diagnosis. In view of the probable malignancy of this lesion, a wide resection of the involved small bowel (18 inches) and of a V-shaped segment of the mesentery was done. The continuity of the bowel was re-established by end-to-end anastomosis. She recovered promptly, leaving the hospital ten days later.

Pathologically, the mass was red and shaggy, 5 cm. in diameter. The mucous membrane at the site of the lesion was granular and dark red in color. There was some encroachment on the lumen by the tumor. Eight to ten lymph nodes ranging from 1 to 4 cm. in diameter were situated in the adjacent mesentery. (Fig. 3.)

Microscopically, the sections presented a neoplastic structure composed of lymphoid cells arranged in groups of follicles which formed large nodes in a fibrous and fatty stroma. These nodes had a fibrous capsule and a peripheral sinus, both of which were often invaded by the lymphoid cells. One section

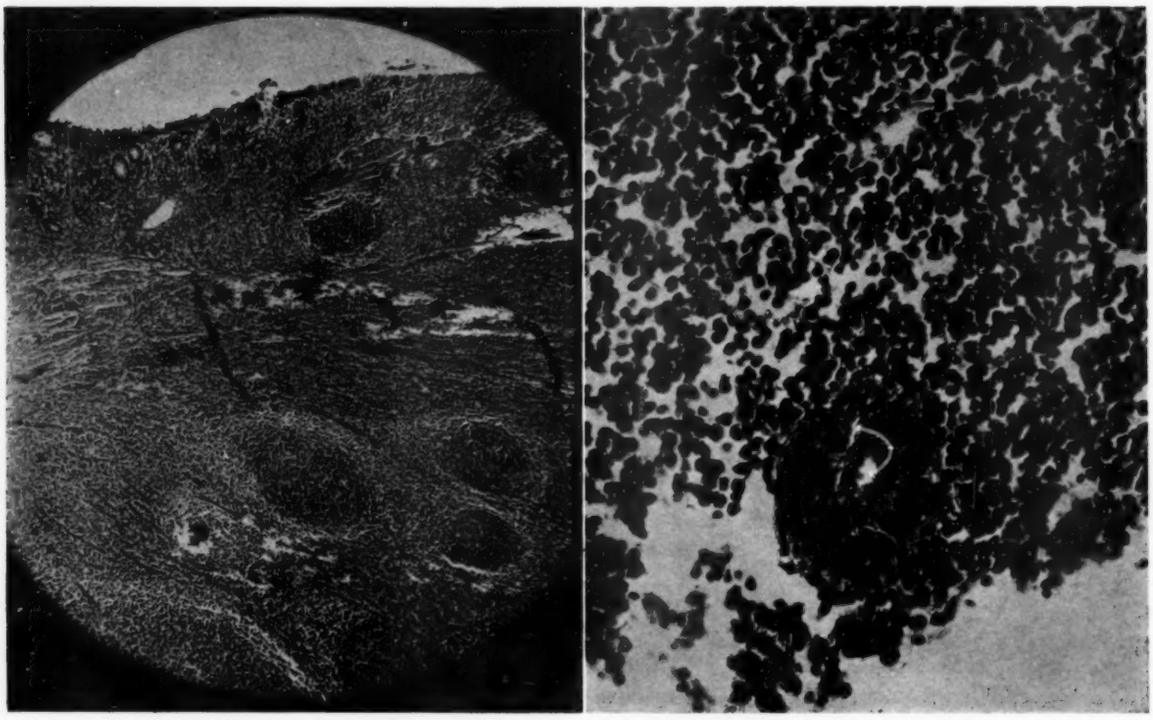

FIG. 4. Sections showing neoplastic structure composed of large nodes in a fibrous and fatty stroma.

showed a similar scattering of these cells in the mucosal stroma, submucosa and muscle layers of the small bowel wall. Coarse subserosal papillae of lymphoid tissue were also present. The follicles varied widely in size, some attaining a diameter in excess of a low-power field. The germinal centers were very large and showed marked endothelial hyperplasia. (Fig. 4.) Diagnosis: giant follicular lymphoma of ileum and mesenteric nodes. The lumen of the specimen was distended with barium and x-rays were made. (Fig. 2.) A minimal disturbance of the mucosal pattern at the tumor site was discernible. This patient did fairly well until April, 1952, a period of one year eight months following surgery. Gradually a firm fixed mass could be outlined in the right mid-abdomen. X-ray therapy was initiated and nitrogen mustard was administered intravenously. There was rapid disappearance of the tumor. Laboratory data revealed: marked anemia, hemoglobin 45 per cent and leukopenia; white blood count 1,600. Anorexia, nausea, weakness and vertigo developed. She responded well to several transfusions and is again improved.

A review of the meager literature on treatment of this disease is summarized as follows: (1) Radical surgical extirpation followed by irradiation when the disease is localized; (2) irradiation when the disease is generalized; (3) Chemotherapy (nitrogen mustard). As this disease is usually multicentric in origin, cure by any present method of treatment is unlikely.

The average survival time is 4.6 years; for lymphosarcoma and Hodgkin's disease it is about two and one-half years and reticulum cell sarcoma about six months. Life has been prolonged in some instances by radiation for ten to fifteen years. In untreated cases 5 per cent are alive at five years while 70 per cent are dead in two years. Irradiation of this disease has produced a 30 per cent five year non-recurrence rate at the Lahey Clinic.

SUMMARY

Follicular lymphoblastoma is a systemic disease which may rarely become evident initially in the small bowel. Diagnosis can be made only by exploration. The treatment of isolated small bowel involvement is wide excision followed by x-ray therapy and observation for further evidence of the disease. Two cases involving the jejunum have been reported in the literature. An additional case involving the ileum was added.

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Thrombosis of the mesenteric veins is either due to injury of the intima, venous stasis or to an abnormal condition of the blood itself. It is not surprising, therefore, that blunt trauma to the abdominal wall may cause mesenteric thrombosis. In treatment it is not enough simply to excise the gangrenous bowel. One must remove all of the thrombosis; otherwise it may continue to extend postoperatively and cause additional gangrenous bowel. If it is going to occur, mesenteric thrombosis does not always immediately follow the trauma; occasionally a month may elapse. Finally, post-traumatic mesenteric thrombosis may occur at several sites causing multiple areas of intestinal infarction. (*Richard A. Leonardo, M.D.*)

CONGENITAL MEGACOLON, ITS ETIOLOGY AND TREATMENT

J. M. McCaughan, M.D., Joseph Ninecurt, M.D. and Robert H. Ruby, M.D.
St. Louis, Missouri

It is sixty-three years since Hirschsprung reported in detail his two cases of congenital megacolon and thus gave his name to this rare disease. Since Hirschsprung's contribution in 1887 many papers have dealt with congenital dilatation of the colon, numerous theories have been proposed to explain its pathogenesis and a diversity of therapeutic procedures have been advocated for its relief. The incidence of the disease is given as one in 20,000 to one in 30,000 live births. Bodian[1] in a genetic study noted that the over-all chance of a male sibling of a known patient being affected is about one in five, whereas in female siblings the chance is very small.

Theories on etiology fall into at least five categories: (1) congenital dilatation with secondary hypertrophy occurring after birth;[10,12] (2) mechanical obstruction due to the elongated and looped colon;[11,18] (3) infection of various types with the dilatation and hypertrophy due to chronic colitis;[20] (4) autonomic imbalance;[3,5,7,13,19] and (5) congenital absence of myenteric ganglia.[9,14,15,17,22]

Whitehouse and Kernohan[22] in a comprehensive pathologic study of the myenteric plexus in eleven cases of congenital megacolon in 1948 found that the myenteric plexus was absent in the most distal part of the colon in all cases, and in 80 per cent of the cases it was absent also in the transitional region (by which they mean the segment where the maximally dilated colon suddenly narrows down to a segment of normal size). In 60 per cent of their cases the myenteric plexus was absent in the lower part of the sigmoid and in 20 per cent the absence of the plexus extended from the rectum into the upper part of the sigmoid and descending colon.

In general, the methods of treatment at present fall into five groups: (1) Medical management consisting of diets, laxatives, enemas and drugs such as mecholyl bromide or syntropan to influence intestinal motility. Mild cases can be controlled for long periods but in severe forms these measures usually fail. (2) Resection of part or all of the dilated bowel. This procedure is based on the belief that the seat of the disease lies in the dilated and hypertrophied segments of the bowel. The fallacy in this approach is exposed according to Swenson et al.[14–17] by the frequent recurrences at the line of resection. Dixon and Judd,[2] however, reported on twenty-five patients with complete relief of a series of forty-one on whom half or less than half of the colon was removed. (3) Lumbar sympathectomy, unilateral or bilateral, combined with presacral, para-aortic and inferior mesenteric chain resections with or without splanchnicectomy. The results of these procedures have not been uniformly satisfactory. (4) Submucous myotomy.[4] Graham[6] used this procedure for megacolon. He adapted the procedure described by Heller[8] and by Wangensteen[21] for the treatment of chronic cardiospasm with dilatation of the esophagus. He cited the results in four cases in which he did a simple myotomy by splitting the muscles in a taenia coli of the sigmoid down to the mucosa for a distance of 6 cm. In three of the children the result was excellent and in the fourth it was unsatisfactory. (5) Resection of the narrow segment of the rectosigmoid distal to the dilated sigmoid. Neuhauser[15] was the first to demonstrate this narrowing radiographically in forty patients with congenital megacolon and to attach clinical significance to it. Swenson, Rheinlander and Diamond[17] made studies of colonic motility with the multiple balloon technic and found an absence of normal propulsive waves in the rectum and rectosigmoid. They believed, therefore, that this constituted a physiologic defect which resulted in chronic obstruction. To quote their conclusions: "In the past the emphasis on Hirschsprung's disease has been directed to the dilated and hypertrophied colon. It is our contention that the primary lesion rests in the distal non-dilated segment despite the fact that grossly the area appears normal."

These studies led Swenson and his associates to develop a special technic for the removal of the narrow, irregular rectum and rectosigmoid, which they did in fifty-two patients with one postoperative death and with one failure. In three patients postoperatively they were able to demonstrate normal colonic peristalsis by balloon studies. The operation described by Swenson and his group, the technical details of which were first worked out on experimental animals, is essentially an abdominoperineal resection of the sigmoid and rectum except the

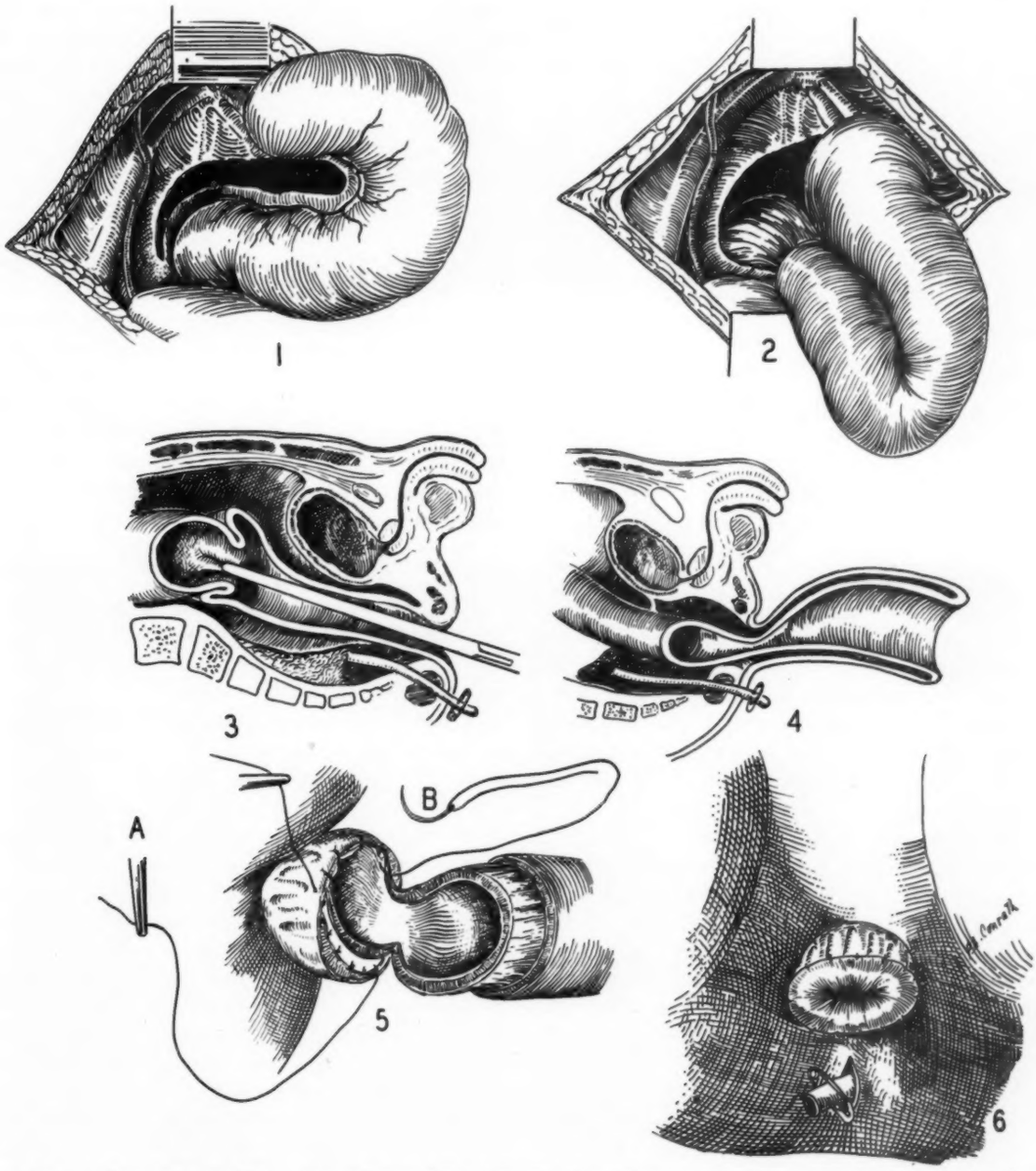


FIG. 1. Operative technic, adapted from Hiatt, R. B., *Ann. Surg.*, 133: 321–329, 1951. (1) Incision in sigmoid mesocolon with ligation superior hemorrhoidal and lower sigmoidal arteries. (2) Exposure of the presacral space which is opened to the perineum by dissection of the rectum from prostate and urethra. (3) Cross section of the pelvis at the beginning of rectal eversion. (4) Rectal eversion completed; note position of drain. (5) Seromuscular row of sutures has been introduced, held in forceps (A); the continuous mucosal suture layer is shown (B). (6) Completed anastomosis; the anus will retract when the tension on levator muscle is released.

anal sphincter and the distal 2 to 3 cm. of rectal wall by a pull-through operation which intussuscepts and exteriorizes the rectum and rectosigmoid through the perineum. This is done after first mobilizing the rectosigmoid by division of the peritoneum, mesentery and superior hemorrhoidal and sigmoidal vessels. The resection and anastomosis is then done externally by one operating team while another reconstructs the peritoneal floor and closes the abdomen.

For our purpose in the case presented herein we adapted the modification used in twenty-three cases by Hiatt,[9] namely, a rectosigmoid resection and pull-through operation done without dividing the rectum intra-abdominally and closing its ends as a preliminary to the pull-through step, as in the Swenson procedure. (Fig. 1.)

CASE REPORT

The patient, an eleven year old colored boy, has been treated at the St. Louis County Hospital since 1942. At the age of one year it was noted that the patient had a protuberant abdomen and there were infrequent bowel movements. Repeated enemas were required. His first hospital admission was on June 22, 1942. A history of vomiting with obstipation for four days was obtained. On examination the abdomen was distended. A barium enema showed some dilatation of the colon but there was evidence of muscular tone and the radiologist thought that the condition could hardly be called Hirschsprung's disease. The patient was relieved with repeated enemas.

Following this episode there were similar recurrent attacks of abdominal distention with obstipation. His second admission was in 1943; his third and fourth in 1944 and 1946, respectively. At the latter admission physical examination showed marked distention of the abdomen. Spinal anesthesia followed by a barium enema showed marked dilatation of the bowel. (Fig. 2.)

His fifth hospital admission was on February 11, 1951, when he was ten years of age. There was a history of obstipation for three days and vomiting for two days. Physical examination showed a markedly distended abdomen with distinct bowel patterns and hyperactive bowel sounds. The rectum was collapsed and no feces could be palpated on digital examination.

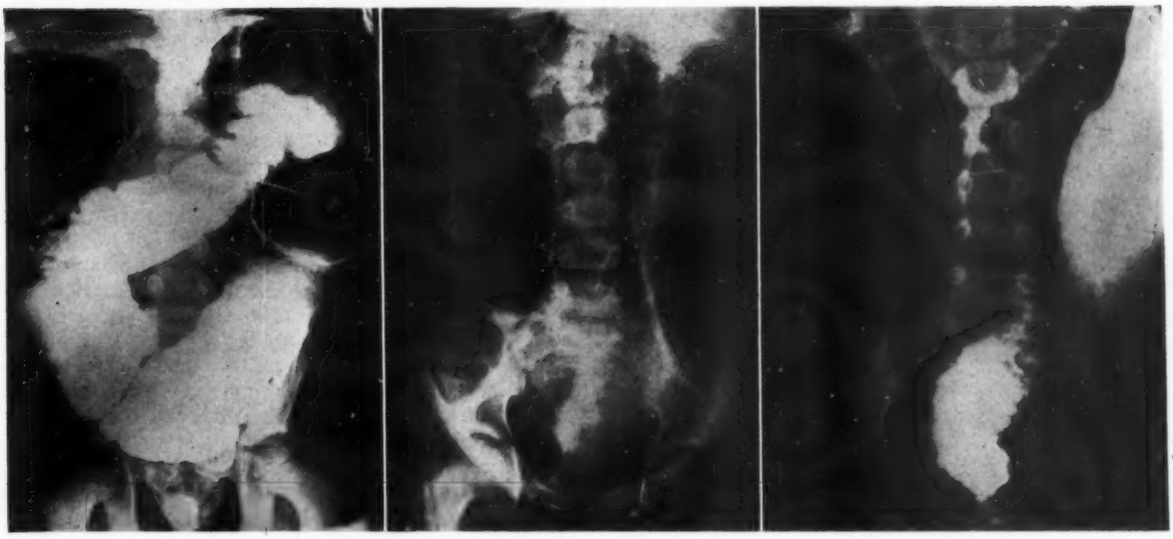
On x-ray examination there was marked distention of the entire colon with gas and feces. The diameter of the colon was about 9 cm. In the upright position numerous gas-capped fluid levels were visualized, and in the transabdominal and lateral decubitus views many of these fluid levels were seen to be in the small intestine, probably the ileum. The condition was thought to be a marked megacolon impacted with feces, probably causing intestinal obstruction. The colon was much larger than at the previous examination in 1946. (Fig. 3.)

Enemas were tried but were unsuccessful. Therefore, an exploratory laparotomy was performed on February 12th through a right McBurney incision. A hard, ovoid fecalith 4 by 6 inches was found impacted at the rectosigmoid causing complete obstruction. The entire proximal colon was tremendously dilated. The fecalith was removed through an antimesenteric incision in the bowel which was then closed. A Gibson type cecostomy was done for decompression. Postoperatively, distention was relieved by cecostomy irrigations and enemas. The general condition of the patient improved markedly. On March 20, 1951, a Hiatt modification of Swenson's operation was performed. (Fig. 1.) On the seventh postoperative day the patient had fourteen bowel movements. The number of bowel movements at the time of his dismissal from the hospital was one daily on the average.

X-ray examination one month later (Fig. 4) revealed that although the colon was still considerably enlarged, its caliber was much smaller than at the preoperative examination.

In July, 1951, the child was seen in the outpatient department. The abdomen was flat and he was gaining weight. The appetite was good and his mother reported that his bowels moved every day although sometimes requiring the aid of a laxative or enema. Rectal examination revealed a slight ring-like constriction at the site of anastomosis but the caliber of the rectum was quite ample and in no way produced stenosis or stricture.

On January 15, 1952, the patient was again seen in the outpatient department. His appetite was still good, he was gaining weight and had returned to school. His mother reported that his bowels were well regulated and that he had a normal bowel movement daily; an enema was required no more often than once a month. On physical examination the abdomen was soft



2 3 4

FIG. 2. Roentgenogram of the colon by barium enema (1946) reveals marked colonic dilatation.

FIG. 3. Roentgenogram of the colon (1951) reveals extensive colonic dilatation of the entire colon with gas and feces. Compare with Figure 2.

FIG. 4. Roentgenogram by barium enema (April, 1951), one month after operation, reveals colon still enlarged but much smaller than at preoperative examination.

5A 5B

FIG. 5. A and B, roentgenograms by barium enema (January, 1952) reveal colon still enlarged but considerably smaller that at previous postoperative x-ray examination. The anastomotic site can be visualized as a narrowed segment in the lower rectum. (A) filling film; (B) evacuation film.

and flat. The operative wounds were well healed. On rectal digital examination the line of an anastomosis could be felt as a distinct ring, narrowing the rectum slightly. The lumen, however, was adequate and readily admitted the examiner's finger. Radiographic examination of the colon by barium enema (Figs. 5A and B) revealed that the caliber of the lumen of the colon was still enlarged but was considerably smaller than at previous examinations. The rectal ampulla was somewhat narrowed in one area, probably the site of the anastomosis.

The gross material was submitted to the Department of Anatomy of St. Louis University Medical School for study and the following report was made: "Samples were taken from all parts of the specimen, fixed in ten per cent formalin, paraffin imbedded and sectioned at fifteen to twenty microns. Control samples were treated in the same manner. Routine hematoxylin and eosin; the Holmes' silver nitrate technique for nerve processes, and the protargol silver proteinate staining techniques were used. In the sample of congenital megacolon studied, no ganglion cells were found either in the myenteric or submucous plexuses. Ganglion cells are normally found in abundance in both the myenteric or Auerbach's plexus and the submucous or Meissner's plexus."

SUMMARY

The result obtained by us in the management of this one case of congenital megacolon is gratifying and is similar to the results reported by Swenson and by Hiatt. We believe that resection of the non-dilated segment of the rectum and rectosigmoid with primary anastomosis offers the best chance for relief in congenital megacolon.

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RUPTURED MULTILOCULAR PSEUDOMUCINOUS CYSTADENOMA OF THE OVARY WITH PLEURAL EFFUSION

EDISON S. SHAW, M.D.
Pleasantville, New York

ALTHOUGH sporadic cases, exhibiting the combination of benign pelvic tumor, ascites and hydrothorax, have been reported in the literature over the past seventy-three years, the total number has been extremely small. It was not until Meigs and Cass[1] reported a series of seven cases in 1937, defining this symptom-complex in detail in a classic report, that it became recognized as a clinical entity. In 1947 Calmenson, Dockerty and Bianco[9] reported a series of nine cases of Meigs' syndrome taken from the records of 20,000 surgically removed pelvic tumors at the Mayo Clinic, covering a period of years from 1910 to 1945, an incidence of 0.05 per cent. The tumors removed included 312 ovarian fibromas, fifty-one of which were complicated by ascites and only two by hydrothorax.

The original report of Meigs consisted of all the same type of tumor (i.e., ovarian fibroma) but the association of ascites and hydrothorax in other types of non-malignant pelvic tumors have been observed since that time. For example the Mayo Clinic report consisted of four ovarian fibromas, one ovarian fibromyoma, one degenerating uterine fibromyoma, one fibromyoma of the uterus with pelvic inflammatory disease of the adnexas, one granulosa cell tumor of the ovary and one complex teratoma of the ovary.

In 1943 Meigs, Armstrong and Hamilton[2] reported thirty cases of this syndrome, all complicating ovarian fibromas, taken from all available literature. Since 1940 there has been an increasing number of reports in which other types of pelvic tumors, both benign and malignant, have been associated with this syndrome. The following authors and the type of tumor reported by them may be mentioned in addition to those already specified in the Mayo Clinic report by Dockerty: Traut and Marchette (1940), theca or granulosa cell tumor of the ovary; MacFee (1941), multilocular cystadenoma of the ovary; Mendel and Tyrone (1944) and Rubin (1944), thecoma of the ovary; Kelemen (1944) and Perlmutter (1944), Brenner's tumor of the ovary; Salmon (1934), uterine fibroid; Millet and Shell (1945), pseudomucinous cystadenoma; Nelson and Dennison (1951), multilocular teratoma of the ovary; Dick, Spire and Worboys, Krukenberg's tumor; Crookston (Australia, 1951), dermoid cyst of the ovary. Cases of carcinoma associated with the syndrome include reports by: Schenck and Eis (1939), papillary cystadenocarcinoma of the ovary; Anderson (1943), malignant cystadenoma.

The startling feature of the cases reported in the literature is that many of them were first considered to be hopelessly malignant and were treated expectantly by multiple aspirations of fluid from the chest and abdomen as well as by roentgen therapy, for periods of a few months to two years. A second striking fact is that practically all the patients recovered and the ascites and hydrothorax disappeared completely following the removal of the tumor, even those in which malignancy was found.

CASE REPORT

A fifty-two year old, nulliparous woman was admitted to Northern Westchester Hospital on August 21, 1952. She had been told she had a pelvic tumor seven years previously at which time it was large enough to cause visible abdominal protuberance. She was symptom-free except for a feeling of weight and pressure until June, 1952, at which time she complained of dyspnea which gradually became worse. On the day of admission, while on the way to the doctor to report this dyspnea, she was suddenly seized with an agonizing pain over her whole abdomen and substernal region, associated with a sensation of suffocation. The pain was excruciating, lasting a half hour or more and she "thought she was going to die." She was then admitted to the hospital

FIG. 1. Hemisection of uterine corpus showing large and small intramural leiomyomas.

and examination revealed two huge tumors, a firm, hard movable one on the right side about 5 inches in diameter and a large cystic mass which seemed to fill the whole left side of the abdomen and true pelvis. The condition was assumed to be malignant in spite of the fact that cachexia, anemia, etc., were not present. It was not until x-rays of the chest, when taken immediately after each thoracentesis, revealed no pathologic condition and no malignant cells or blood in the pleural transudate that Meigs' syndrome was suspected. These thoracenteses were carried out on five different occasions and a total of 7,500 cc. of fluid was removed during a period of two weeks. Operation was carried out on September 11th, approximately three weeks after admission.

At operation the abdomen was found to be filled with pseudomucinous fluid which would barely pass through the suction tube and most of it had to be scooped out with the palm of the hand. A large leiomyoma of the uterus was found which was about 15 cm. in diameter occupying the right side of the abdomen. (Fig. 1.) On the left side there was a huge multilocular cystic mass with grayish white glistening surface very tightly wedged into the pelvis and extending up the left side of the abdomen as far as the rib margin. (Figs. 2 and 3.) There was a rent in the posterior surface of one of the cysts through which mucinous material was escaping. This ovarian cystic tumor was removed and a hysterectomy with partial enucleation of the cervix was done. Recovery was rapid and uneventful, and to date there has been no clinical or x-ray evidence of reaccumulation of fluid in the chest or abdomen.

Pathologic report was as follows. Gross: The first specimen was a supracervical segment of uterus, 15.0 cm. in widest diameter, with one ovary and oviduct attached. The corpus of the uterus was markedly distorted by a large, intramural fibroid, 11.0 cm. in widest diameter. It was composed of dense whorls of pale tan, fibromuscular tissue. The endometrial cavity was patent, but compressed and displaced to one side. At the fundus there was an elongated polyp, 3.0 cm. in widest diameter, with reddish pink external and cut surfaces. The attached ovary (2.0 cm.) was atrophic and the oviduct was not remarkable. The second specimen was a large, lobulated, cystic mass, 23.0 cm. in widest diameter. The external surface was pinkish tan and smooth. In one area, however, there was compressed ovarian tissue, plus a flattened round ligament and oviduct. The compressed ovarian tissue contained a small corpus luteum. There were no external excrescences on the surface of the cyst. On section the cyst was multiloculated and contained approximately 1,500 cc. of thick, tan, viscid, pseudomucinous material. The largest cystic compartment contained a soft, solid, papillary mass 12.0 cm. in widest diameter. The cut surfaces of this mass were unusually soft and friable, and were bathed in a copious amount of mucinous material. The mass was attached to the capsule of the cyst by a broad base, 6.0 cm. in widest diameter.

Microscopic: The large ovarian cyst was lined by innumerable, interlacing papillary villi covered by a single layer of tall columnar epithelium. (Fig. 4.) The majority of the epithelial cells had nuclei compressed at the base by large cytoplasmic vacuoles (goblet cells). (Fig. 5.) The majority of the nuclei were hyperchromatic, and an occasional mitotic figure was noted. In one area the epithelium was somewhat atypical and the underlying stroma was invaded by strands and cords of epithelial cells.

The uterine polyp was partly covered by columnar epithelium of the endometrial type, beneath which there was compact stroma interspersed with slightly dilated, endometrial glands. The uterus was lined by hypoplastic endometrium, and the fibroid composed of

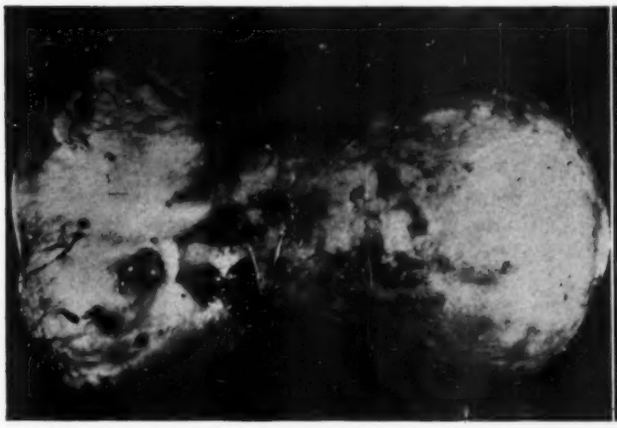

FIG. 2. Pseudomucinous cystadenoma of the left ovary.

FIG. 3. Interior of pseudomucinous cystadenoma of left ovary.

FIG. 4. Photomicrograph of cyst wall showing interlacing papillary villi. × 4.

FIG. 5. Photomicrograph showing tall columnar epithelium and enormous goblet cells. × 45.

whorls of fibromuscular tissue. The ovarian parenchyma was almost completely replaced by corpora albicantia and sclerosing blood vessels. The villi of the oviduct were covered with columnar epithelium. The wall was not altered.

Diagnosis was multiloculated pseudomucinous cystadenoma of ovary; leiomyoma uteri; polyp of endometrium; pseudomyxoma peritonaei.

Note: The tumors were not weighed by the pathologic department but as the patient weighed 162 pounds prior to operation and only 112 following removal of the tumors, it must be assumed that together they weighed approximately 40 pounds, as the patient ate well during her hospital admission.

Comment: In the present case I make no claim of offering much additional information to a subject so clearly brought to our attention by the previously mentioned authors. However, this case differs from the others in certain respects. Two tumors of the pelvis are involved (1) a large leiomyoma of the uterus and (2) a huge multiloculated pseudomucinous cystadenoma of the ovary. Furthermore, one of the mucinous cysts had ruptured three weeks prior to operation, thus complicating the situation with pseudomyxoma peritonaei. It must be assumed that the pain suffered in August, 1952, was caused by the sudden rupture of one of the compartments of the multilocular pseudomucinous cyst. A further interesting complication, although not specifically related to the subject of Meigs' syndrome, was that this patient, a nullipara, developed

a large enterocele postoperatively due to intrapelvic pressure. This was suspected to be a rectocele preoperatively.

A description of this case with pathologic findings was sent to Dr. J. V. Meigs for his opinion as to whether it could be considered a true Meigs' syndrome. In reply he stated that it should be considered a case of this syndrome and further stated that more and more of these cases are being reported all the time and that most of them are fibromas, thecomas, granulosa cell tumors or solid tumors—occasionally it is a cystic tumor and occasionally a fibroid.

The causative mechanism of the development of ascites and unilateral hydrothorax is still the subject of considerable controversy. In the past the occurrence of ascites in connection with tumors of the ovary was considered practically sure evidence of malignancy. The occurrence of hydrothorax as well as ascites made the diagnosis of malignancy a foregone conclusion. The mere presence of ovarian fibromas in the pelvic cavity is not in itself sufficient cause for the production of fluid, nor does the size of the tumor seem to have a specific relation to this phenomenon. As a corollary, pressure on the lymphatics causing obstruction must not be considered the cause of the fluid. The production of ascites, or ascites plus hydrothorax, has not occurred however in tumors smaller than 6 cm. in diameter. A feature which seemed to be common to most of the associated tumors is edema of the tumors themselves and degenerative cyst formation. Associated pelvic pathologic lesions, especially uterine fibromyomas, are not uncommon.

The mode of transference of the fluid from the peritoneal cavity to the pleural cavity has been especially inconclusive. Considerable experimental work has been done by such men as Lemon and Higgins and by Meigs and many divergent theories advanced. Lemon et al. have shown that, in animal experiments, fluids as well as particulate matter and bacteria are removed by the diaphragmatic lymphatic spaces. The transference of fluids by this route may depend on osmotic pressure resulting from the high colloidal content of the ascitic fluid. A theory which has been suggested by others and with which I agree is that this transference of fluid from the abdominal cavity to the pleural cavity occurs in other forms of ascites, but is so rapidly absorbed that an accumulation of fluid in the chest does not occur in sufficient amount to be detected clinically. A further discussion of many other possible theoretic causes of this phenomenon are discussed extensively in many of the previously published articles, especially the report by Calmenson et al.[9] in 1947 from the Mayo Clinic.

SUMMARY

A case of Meigs' syndrome caused by multilocular pseudomucinous cystadenoma of the ovary has been presented. The rarity of this case is emphasized by the fact that I have been able to find records of only two other cases with similar pathologic disorder in the literature, i.e., Meigs' syndrome associated with this type of tumor.

The syndrome usually consists of ascites and hydrothorax associated with a benign pelvic tumor, nearly always ovarian, and is cured by surgical removal. Although in this case the peritoneal cavity contained mucinous fluid instead of ascitic fluid, it still emphasizes the importance of keeping the syndrome constantly in mind and not considering such a case hopelessly malignant.

Acknowledgments: Grateful acknowledgment is made for the assistance given by Dr. Robert A. Fox, Pathologist of Northern Westchester Hospital, and Dr. William Granger of Chappaqua, New York, in arriving at the proper diagnosis of this case preoperatively. Photographs were prepared by Mr. John C. Orr, United Nations Photo Laboratory.

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S. Yuya studied postoperative digestion and absorption after subtotal and total gastrectomies. Following subtotal gastrectomy these results were eventually similar to those of normal human beings. In totally gastrectomized patients, if the duodenum was anastomosed to the esophagus, postoperative digestive results more nearly approached the normal than when the esophagus was anastomosed to the jejunum. In these latter instances stool examinations revealed evidences of incomplete digestion and absorption of fats and even of proteins. However, if a loop of jejunum was anastomosed to the esophagus at one end and to the duodenum at the other end (thus forming a gastric pouch to replace the totally removed stomach, Tomoda's operation), postoperative digestion and absorption was very satisfactory. (*Richard A. Leonardo, M.D.*)

VOLVULUS OF THE STOMACH

JOHN P. WEST, M.D. AND VAUN T. FLOYD, M.D.
New York, New York

VOLVULUS of the stomach which results in obstruction of the esophageal and duodenal orifices is a rapidly progressive and fatal condition unless corrected by early operation.

FIG. 1. Roentgenogram following barium meal showing that most of stomach is above the diaphragm.

The more common type of gastric volvulus is due to incarceration and torsion of the stomach within a diaphragmatic hernia.[1–5] Symptoms of acute high intestinal obstruction develop in patients with this type of volvulus. There is no abdominal distention and the significant physical and roentgen signs indicate fluid and usually some air in the chest.

A less common form of volvulus is due to rotation of the intra-abdominal stomach.[6–9] Patients with this type of volvulus complain of severe pain. The abdomen becomes distended and although nausea is constant, attempts to vomit are unsuccessful except for the return of those fluids which have been retained in the esophagus. Roentgen examination reveals a distended abdominal viscus and a swallow of barium suffices to demonstrate obstruction at the lower end of the esophagus.

The case herein reported is the only one recorded at St. Luke's Hospital during the past twenty years. It also appears to be unique in that the patient had a large diaphragmatic hernia, which often contained a major portion of the stomach, but at operation the distended and twisted stomach was intra-abdominal except for a small portion of its fundus. The rarity of this condition warrants re-emphasis of the clinical features which may lead to early diagnosis and proper treatment.

CASE REPORT

Mrs. E. T., age sixty-six, was first seen in the medical clinic of St. Luke's Hospital in 1945. At that time she gave a history of epigastric distress and occasional bouts of vomiting which, however, had not interfered with nutrition or ability to work. A roentgenogram of the chest showed a gas shadow above the diaphragm and to the right of the midline. Subsequent barium studies confirmed the diagnosis of a diaphragmatic hernia containing part of the stomach. (Figs. 1 and 2.) Repair of the hernia was advised but the patient thought that her symptoms were not severe enough to warrant operation and she continued her work as a hospital maid.

She was admitted to the hospital on March 30, 1951, complaining of crampy abdominal pain, distention and obstipation of two days' duration. Although nauseated, the patient had been unable to vomit. At the time of admission she appeared dehydrated and acutely ill. The abdomen was markedly distended, respirations were shallow and definite cyanosis was present. Blood pressure was 96/78, pulse 110 and tem-

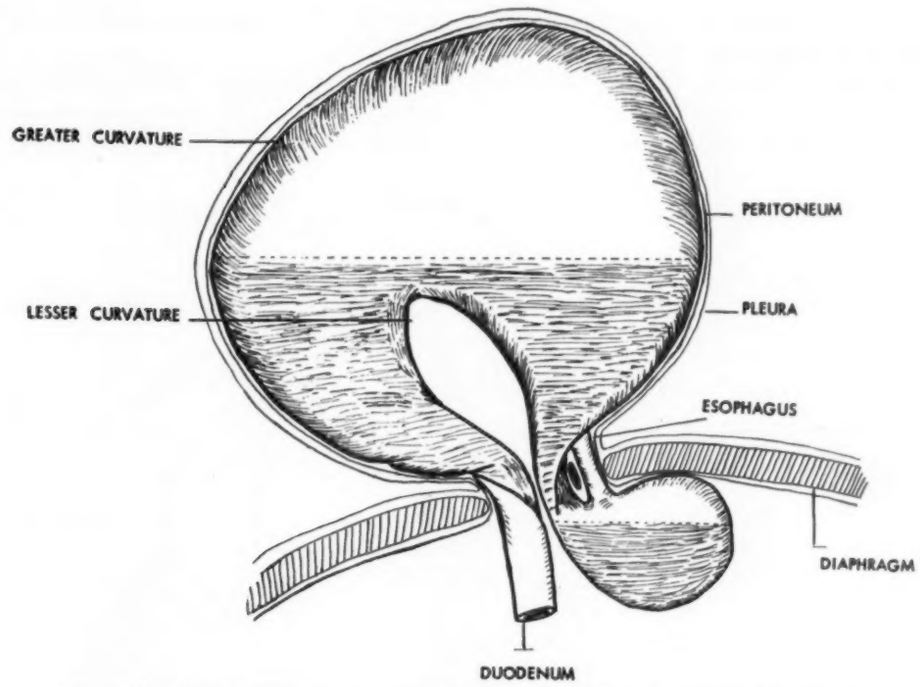

FIG. 2. Drawing shows the parahiatus hernia containing stomach as in Figure 1.

FIG. 3. Roentgenogram with patient in supine position after swallowing barium. A markedly distended viscus is seen with a small amount of barium in esophagus.

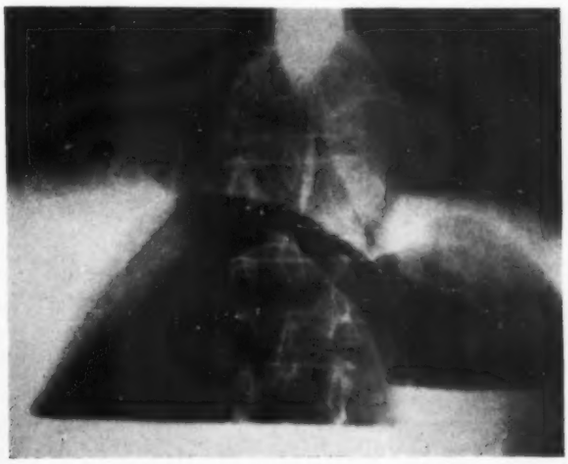

FIG. 4. Roentgenogram with patient standing. Three fluid levels are seen and again the barium remains in the lower esophagus.

perature 103.6°F. Roentgenograms showed (Figs. 3 and 4) a large distended viscus filling the upper abdomen. Fluid levels were noted on the films taken with the patient in an upright position and confirmed the impression that only a small part of the stomach was above the diaphragm.

Attempts to pass a gastric tube were unsuccessful and after a short period devoted to administration of intravenous fluids, the patient was operated upon. She was found to have an enormously dilated stomach which had rotated in such a way that the pylorus was under the left diaphragm and the fundus was rotated to the right with a major portion of the posterior wall presenting anteriorly. The pyloric and esophageal orifices were obstructed. (Fig. 5.) The stomach was emptied by means of a trochar and returned to its normal intra-abdominal position. Improvement was rapid and the patient's hospital course was uncomplicated. Barium studies prior to discharge showed the stomach to be below the diaphragm but partially rotated on its long axis in such a way that the lesser curvature tended to present anteriorly.

Repeat roentgen studies two months later revealed that the stomach was again in the hiatus hernia. Although she had no symptoms, the patient at this time agreed to have the hernia repaired. This was done on June 23, 1951, through a combined thoraco-abdominal incision. The hernia was found to be of the parahiatal type with the defect in the diaphragm to the right of the esophageal hiatus. The sac of the hernia extended up into the posterior mediastinum for an estimated distance of 16 cm. The stomach was withdrawn without difficulty and the neck of the sac divided and closed without excision. The defect in the diaphragm was closed by interrupted sutures of silk. Again the postoperative course was uncomplicated and the patient has remained free of all gastric symptoms. Roentgenograms one year later showed no evidence of recurrence of the hernia. Some rotation of the stomach has persisted.

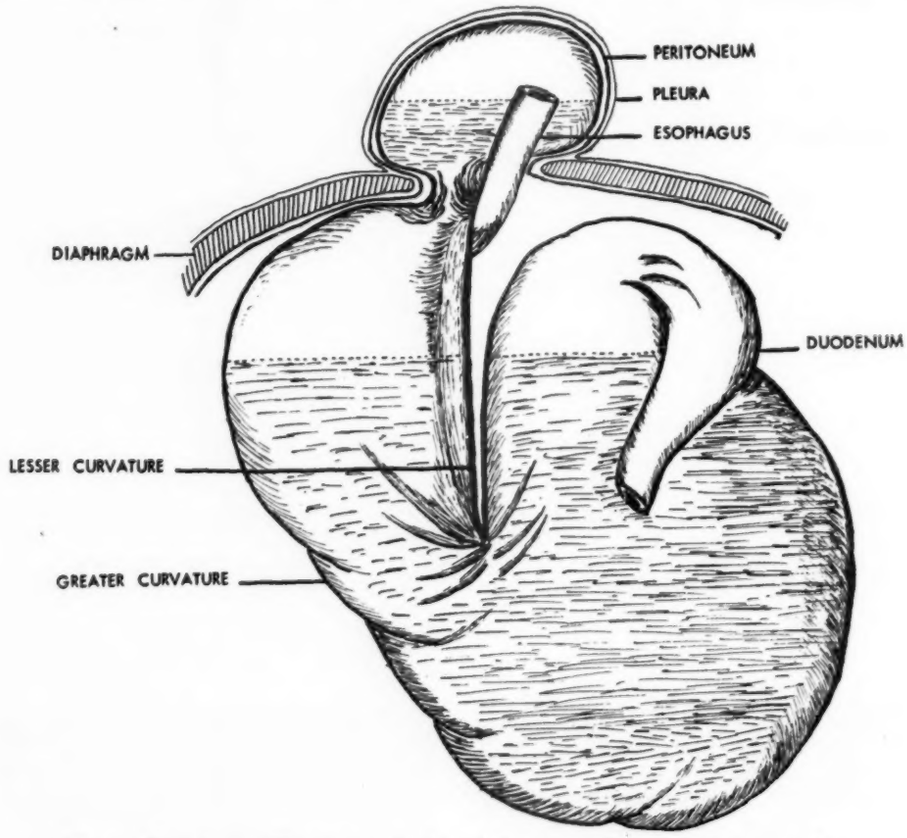

FIG. 5. Drawing to illustrate volvulus of the stomach as found at operation.

CONCLUSIONS

1. Acute epigastric pain, abdominal distention and the inability to vomit gastric contents are suggestive of volvulus of the stomach.

2. The diagnosis may be confirmed by roentgenography.

3. Immediate surgical relief of the obstructing volvulus is imperative.

4. Associated defects, such as a diaphragmatic hernia, should be corrected at a later date.

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Children born with spina bifida and rectal incontinence can be helped by construction of a substitute sphincter muscle. Pickrell and colleagues obtained good results in several such children by transplanting the gracilis muscle with its intact blood and nerve supply. This forms an excellent voluntary sphincter for the rectum although it is not an automatic one. At any rate, satisfactory rectal continence results. (*Richard A. Leonardo, M.D.*)

VOLVULUS OF THE CECUM*

GERARD DESFORGES, M.D. AND HUGH WILSON, M.D.
Boston, Massachusetts

VOLVULUS of the cecum is one of the rarest causes of intestinal obstruction[7,17–19] and the infrequency with which it is met in clinical practice makes for difficulty in diagnosis. Early recognition, however, is of the utmost importance since procrastination in the institution of treatment will lead frequently to mortality.[9,17,19] Although several excellent reviews on cecal volvulus have appeared in the literature,[4,6,15,17,19] the experience of any one physician or group of physicians relative to the sequence of diagnosis and surgical treatment remains limited. Because of this most cases are diagnosed at operation or autopsy.[3,12,17] In spite of its rarity we believe that the diagnosis of volvulus of the cecum can be made readily with a careful history and proper interpretation of x-ray films of the abdomen. Once this diagnosis is established treatment can be carried out quickly and effectively.

The following case report of a cecal volvulus is of interest because of cecal perforation prior to hospital admission and because of a clear demonstration of the initiating factor which caused the abnormal rotation.

CASE REPORT

S. Mc., a seventy-three year old white woman, was admitted to the Boston City Hospital at 1:40 P.M. on November 28, 1951. Six days prior to admission the patient had noticed the onset of lower abdominal crampy pain which persisted and became progressively worse. Two days before admission two enemas were taken without relief. Repeated episodes of vomiting started at about the same time. Because of the increasing pain and frequent vomiting the patient's physician advised admission to the hospital. At the time of entry there had been no bowel movements nor passage of flatus for six days. The vomitus was fecal in character. The patient denied any previous abdominal complaints or any change in bowel habits. There was no history of weight loss, hematemesis, melena or jaundice. There had been no previous surgery.

Physical examination revealed an acutely ill, pale, dyspneic, elderly, white woman complaining of generalized abdominal pain. Oral temperature was 100°F., pulse 120 per minute and respirations 40 per minute. Blood pressure was 140/90. Lung fields were resonant and only a few rhonchi were noted over the lower lobes. The heart was normal. The abdomen was markedly distended and there was generalized tenderness. On percussion the entire abdomen was tympanitic. Peristaltic sounds were not heard. On rectal examination there was diffuse tenderness.

Laboratory findings were as follows: urinalysis revealed pH 6.0, specific gravity 1.018, albumin negative, sugar negative, microscopic sediment negative; white blood count was 27,500; hemoglobin 16.0 gm. per cent; blood urea nitrogen was 33 mg. per cent; carbon dioxide combining power 52 volumes per cent; chlorides 78 mEq.

On admission, roentgenograms of the abdomen in the sitting, left lateral decubitus and supine positions (Figs. 1 and 2) were interpreted by Dr. George Farrell of the x-ray department as suggestive of a volvulus of the cecum with perforation.

Preparations were made for immediate operation. Intravenous fluids were started and a Harris tube was passed. Under spinal anesthesia the abdomen was opened through a long right rectus incision. A hiss of escaping gas was noted on opening the peritoneum, and a tremendously dilated loop of colon, covered with purulent exudate, presented in the wound. On the lateral aspect of the dilated loop a tiny 0.2 cm. area of questionable viability was noted. This was assumed to be the point of perforation but had apparently sealed over. The taeniae were separated in the direction of their fibers. Carefully a hand was passed beneath the distended loop which could be identified as the cecum and ascending colon

* From the First (Tufts) Surgical Service, Boston City Hospital, Boston, Mass.

FIG. 1. Left lateral decubitus film. Free air is noted between the liver and overlying abdominal and chest wall. In addition a markedly distended bowel loop with a fluid level can be seen beneath the liver.

which had rotated 180 degrees in a clockwise direction. With a gentle lifting motion the volvulus was reduced. Aseptic decompression was attempted with a Wangensteen apparatus but was unsuccessful, and resort was made to the introduction into the cecum of a large Pezzar catheter. This was then passed through the omentum and right lateral stab wound as a cecostomy tube. Immediate connection to a drainage bottle allowed the gas and feces to escape while the operation was being completed. A small amount of feces was seen leaking from the area of questionable viability, so it was closed with two layers of interrupted No. 00 chromic catgut sutures. No further exploration was carried out because of the presence of peritonitis.

Following operation the patient was given 1 gm. of aureomycin per day for four days. Convalescence progressed satisfactorily, but ten days postoperatively an additional fecal fistula developed in the primary wound. To learn the cause of her cecal volvulus barium enema studies were done. These revealed an intussuscepting polypoid mass of the descending colon. On January 31, 1952, segmental resection was carried out for this lesion.

The microscopic pathologic diagnosis was "mucinous adenocarcinoma of the colon." Convalescence from this operation proceeded uneventfully. However, the fecal fistula in the laparotomy wound persisted. When last seen two months following discharge, and four months after the original admission, the fecal fistula in the right lower quadrant, though smaller, was still present. The patient refused operation for its closure.

FIG 2. Flat film of the abdomen showing the distended cecum rotated toward the left upper quadrant.

COMMENTS

It is generally agreed that incomplete fixation of the cecum or ascending colon must be present in order for volvulus to occur.[4,9,17–19] However this must be only part of the pathogenesis of this disease. Various investigators have pointed out that this anatomic anomaly occurs in from 10 to 30 per cent of autopsy material.[4,9,13,18,19] Since volvulus of the cecum is an extremely rare form of intestinal obstruc-

tion, one cannot consider non-fixation of the cecum as the only cause. It is more likely that there is some initiating factor such as mechanical obstruction distally, as was demonstrated in the present case, which is the precipitating factor in cecal rotation. Sweet[17] has listed these inciting causes as overeating, distention of cecum with feces or gas, vigorous physical activity after overeating, high roughage diet, drastic purgation, pressure of an enlarging parturient uterus, violent coughing, diarrhea and incarceration of a dilated cecum in a hernia especially of the umbilical type.

The initial diagnosis of volvulus of the cecum frequently is not made because the clinical picture is not a familiar one and the wrong interpretation is placed on the roentgen findings. History usually reveals previous similar attacks of somewhat lesser severity[4,5,9–10,11,13,20] which have remitted spontaneously with enemas or change of position. Frequently these preliminary attacks have been diagnosed as recurrent appendicitis.[1,6] The physical examination shows varying degrees of distention of the abdomen with associated tenderness in proportion to the degree of devitalization of the bowel wall. The x-ray findings are undoubtedly the most important single factor in making the diagnosis. Simple scout films of the abdomen reveal a large empty space in the right iliac fossa, and the greatly distended cecum usually lies in the left upper quadrant where it has been mistaken for a dilated stomach. There is also frequently associated a considerable dilatation of small bowel with fluid levels in the upright position.[2,8,14,16] The finding of fluid levels in the small bowel may be somewhat confusing at first; but since with cecal torsion there is immediately obstruction of the terminal ileum, it is readily understandable. With the other findings listed it further substantiates the diagnosis.

Treatment of cecal volvulus depends upon the condition of the patient, the situation encountered in the abdomen and the technical capabilities of the surgeon. In the present reported case it was believed that the least technical interference compatible with restitution of the volvulus and fixation would be the only safe procedure. This was accomplished by decompression, detorsion and tube cecostomy. Other surgical maneuvers recommended vary from resection of the right colon with primary ileo transverse colon colostomy in the good risk patient to the Mikulicz type of exteriorization resection in those patients who are critically ill.[14] With simple detorsion some form of cecopexy is necessary since otherwise recurrence is likely.[3] In general it may be said that the earlier the surgical intervention is carried out the better the prognosis.[6,12]

SUMMARY

1. A case of volvulus of the cecum with associated perforation is presented.

2. Colonic obstruction secondary to an intussuscepting, polypoid carcinoma was believed to be of etiologic significance in this patient.

3. The difficulties of proper early diagnosis are discussed, and the salient features to be sought in a suspected case are emphasized.

4. Variations in surgical treatment depending upon the condition of the patient, the conditions met within the abdomen and the technical capabilities of the surgeon are outlined.

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For patients with "curable" adenocarcinoma of the prostrate, Perry B. Hudson strongly recommends radical perineal prostatectomy, estrogen therapy and castration (bilateral orchidectomy). This procedure was adapted in forty consecutive cases of prostatic cancer in which biopsy showed the growth to be confined to the prostate itself. It will be necessary to follow up patients for several years; results for the first year are very satisfactory. (*Richard A. Leonardo, M.D.*)

BENIGN NON-TRAUMATIC STRICTURE OF THE LEFT INTRAHEPATIC BILE DUCT

JEROME J. WEINER, M.D. AND SAMUEL LACORTE, M.D.
New York, New York

BENIGN strictures of the intrahepatic bile ducts have not received the same recognition as have the lesions of the extrahepatic bile ducts. Walters in 1933, Lahey in 1936 and 1937, and Cattell in 1947 wrote extensive monographs on benign strictures of the extrahepatic ducts, their causes and methods of treatment. Longmire and Sanford in 1948 presented a method for the surgical treatment of extensive obstruction of the extrahepatic biliary radicals by performing a partial hepatectomy and anastomosing the jejunum to a dilated intrahepatic duct.

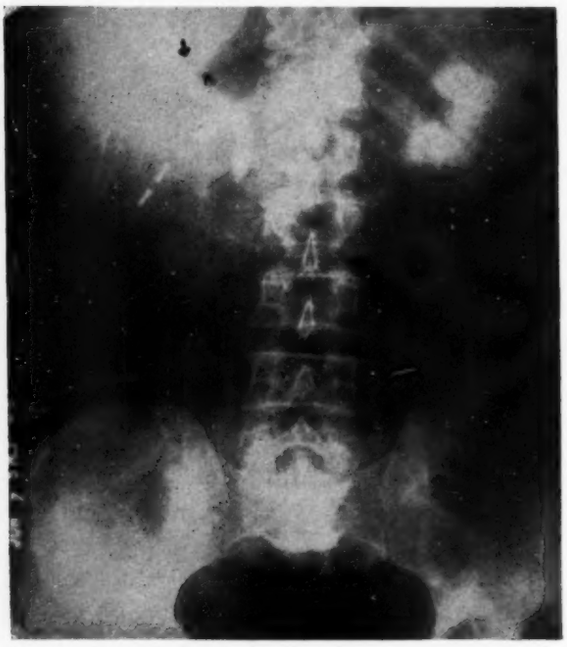

FIG. 1. First cholangiogram one week postoperatively reveals narrowing of the left hepatic duct with dilatation proximal to the stricture.

Carter and Gillette in 1951 published a report of fifteen cases of benign strictures of the intrahepatic bile ducts. These authors emphasized the importance of operative cholangiography in clarifying the causes of biliary obstruction due to benign intrahepatic strictures, which lesions heretofore had been relegated to the category of cirrhosis when no other cause of the obstruction presented itself. Carter and Gillette should be complimented for having stressed the importance of cholangiographic studies in arriving at a more definite diagnosis of intrahepatic lesions. They showed that they were able to find these intrahepatic strictures either by probing into the hidden portion of the hepatic ducts, which in all cases were within the porta hepatis, or by means of a cholangiogram. The importance of their observations, recommendations and conclusions is clearly demonstrated in the case described herein. It is a case of benign stricture of the left hepatic duct, non-traumatic in nature, which was demonstrated by postoperative cholangiographic studies. Had a cholangiogram been taken at operation, the stricture would have been recognized immediately and treated according to the accepted surgical procedure, either by dilatation and insertion of a T-tube or by cholangioduodenostomy.

CASE REPORT

B. R., a sixty-seven year old white man, was admitted May 24, 1951, with the chief complaint of pain in the right upper quadrant of the abdomen for the past few weeks. The pain was constant, dull aching in character and did not radiate to the back or to the shoulders. The pain was not affected by fatty foods. Two days before admission to the hospital he vomited for the first time. He noticed that he had become jaundiced and that the jaundice was increasing in intensity. Itching of the skin was not too severe. He stated that he had had a previous attack of jaundice a few years previously which cleared. There was no weight loss. His past history was negative except for a prostatectomy four years before, at which time a benign lesion was removed.

Physical examination revealed tenderness in the right upper quadrant of the abdomen. The liver and gallbladder were not palpable. The spleen could not be palpated.

FIG. 2. Second cholangiogram shows persistence of the stricture one month after operation.

FIG. 3. Third cholangiogram four months postoperatively; stricture still present.

Laboratory work-up at this time revealed the following: Blood count: hemoglobin 14.5 gm., red blood cells 4,600,000, white blood cells 7,700, polymorphonuclears 68, eosinophils 1, monocytes 1 and lymphocytes 30. Urine: no abnormal findings. Liver tests: cholesterol 195, esters, 85, icteric index 35, alkaline phosphatase 6.6, cephalin flocculation 2 plus. The patient's temperature was 99.8°F. and pulse 84.

For six days before surgery was performed the patient was given supportive treatment in the form of intravenous glucose, amogen, vitamins and daily injections of synkayvite. The jaundice became more intense and the patient was prepared for surgery.

Through a right subcostal incision the gallbladder was found to be swollen, edematous and distended. The omentum was adherent to the fundus and to the body of the gallbladder. The cystic glands were enlarged, as were the glands in the posterior aspect of the gastrohepatic omentum. Cholecystectomy was performed and a T tube inserted into the common duct. No cholangiogram was taken at the time of operation due to the pathologic condition which was found in the gallbladder.

The pathologic report was as follows: Macroscopically, the gallbladder was 10 by 4 cm. The wall was very edematous with areas of congestion on the surface. The gallbladder was filled with thick, mucoid bile. The mucosa was velvety and there was a tortuosity of the lumen with formation of compartments at the narrow pole. Microscopically, all the layers were edematous and infiltrated with lymphocytes and eosinophils. The mucosa formed folds which were covered with columnar epithelium. The epithelium was absent at the tips of a few of the folds.

One week postoperatively a delayed cholangiogram was taken through the T-tube. A film taken following the injection of diodrast showed the common duct, as well as the common hepatic duct and the right biliary tree, within normal limits. (Fig. 1.) The left hepatic duct, however, showed a contraction at its junction with the right hepatic duct. Proximal to the narrowing of the lumen of the left hepatic there was marked dilatation of the duct. The sphincter of Oddi was patent and a considerable portion of the diodrast material was observed to be within the duodenum and also

the upper portion of the jejunum. The roentgenologist reported dilatation of the left hepatic duct secondary to possibly a stricture at the distal end of this duct. The laboratory reports at this time (June 11th) showed the following: cholesterol 305, icteric index 6 and alkaline phosphatase 9.31. Culture of the bile revealed Proteus vulgaris organisms and the bile did not contain any enzymes.

Follow-up cholangiograms, taken one month and four months after surgery, showed the lesion unchanged. During the four-month period the T-tube was clamped off for weeks without any complaint. The stools were brown and there were no episodes of chills, fever or jaundice. (Figs. 2 and 3.)

When last seen the patient was working and was pursuing his normal life.

COMMENTS

It is my opinion that the jaundice in this case was produced as a result of congenital stricture of the left intrahepatic duct. Following the first attack of cholangitis, bile sand or a calculus may have accumulated above the site of the stricture. This bile detritus may have been extruded spontaneously, relieving the jaundiced state. During the course of the cholecystectomy, following the second attack, the sand or the calculus may have been extruded during the surgical procedure causing the jaundiced condition to clear. Since there is no other explanation as to the cause of the jaundice, I presume that if the strictured state of the left intrahepatic duct persists there will be a recurrence of the jaundice with the associated symptoms of chills and fever.

SUMMARY

A case of benign stricture of the left intrahepatic duct has been presented. Ordinarily this case of jaundice might have been relegated to the category of biliary cirrhosis if a cholangiogram had not been performed. There are two lessons to be learned from this case:

1. If an operative cholangiogram had been performed as recommended by Carter and Gillette, the stricture of the left hepatic duct would have been demonstrated and the necessary procedure instituted to clear up this condition.

2. Since the delayed cholangiogram revealed the site of the pathologic condition (stricture of the left hepatic duct) and if the T-tube is withdrawn and the symptoms of chills, fever and jaundice reappear, the site of the obstruction is known and the necessary surgery can be instituted.

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HYDROCORTISONE IN TENNIS ELBOW

IRVIN STEIN, M.D., RAYMOND O. STEIN, M.D. AND MARTIN L. BELLER, M.D.
Philadelphia, Pennsylvania

TENNIS elbow, known also as radiohumeral bursitis, epicondylitis or epicondylalgia, is a common and troublesome affliction. It is characterized by pain originating around the outer side of the elbow joint at or below the lateral epicondyle. Radiation is frequent down the forearm. It is said to occur principally in individuals who are carrying out frequent pronation—supination movements of the almost fully extended elbow. It may be related to athletics or it may be occupational in nature.

The exact pathology of this entity is still debatable as is probable in many similar entities. The pathologic findings are multiple in nature since many changes in the soft tissues could be responsible for the symptoms attributed to this condition. The most commonly favored etiologic theory is that the symptoms result from an incomplete tear of the lateral epicondylar origin of the forearm extensor tendons. It is believed that the partial rupture may occur acutely or may be more gradual in onset. Another form is on the basis of a bursitis with or without amorphous calcium, and an actual bursal sac lying between the common extensor tendon and the lateral epicondyle has been described in 16 per cent of cases.

In most cases conservative treatment is successful in alleviating or completely relieving the painful symptoms. Physical therapy is a useful adjuvant. Local procaine injections are occasionally successful in some hands. However, a very acute and painful flare-up of symptoms usually results from procaine infiltrations; when such a reaction occurs, the result is usually poor. Many people favor the support of the wrist in the cock-up position in order to relieve the strain on the extensor tendon origin.

Various specific manipulations under anesthesia have been described. Basically, these attempts are to convert what is believed to be a partial tear of the extensor tendon into a complete and painless tear. Mills forces the elbow into extension while the wrist and fingers are flexed and the forearm is fully pronated. Cyriax extends the elbow with the forearm in supination and forcibly adducts it.

Certain intractable cases must be explored. Occasionally, a small bursal sac is found between the external epicondyle and the common extensor tendon origin. Excision of this results in complete relief. When a bursal sac is not found, the surgery involves a scratching of the origin of the tendon over the humeral epicondyle. Watson-Jones has described it as "a hen scratching in the barnyard." Surgery usually results in complete and permanent cure.

The success of hydrocortisone in the local inhibition of mesenchymal proliferation prompted us to use it in five cases of tennis elbow. No other adjuvant therapy was given to these patients. In four cases relief was dramatically obtained. One patient failed to respond to two injections of hydrocortisone.

CASE REPORTS

CASE I. C. M., a sixty-four year old white man with pain and tenderness over the right elbow was seen. There was aching discomfort about this right elbow on its lateral aspect for about a year. A few weeks before he consulted us it had been particularly aggravated as a result of trout fishing. A single injection of 25 mg. (1 cc.) of hydrocortisone was given into the lateral aspect of the right elbow on the tender area. There was a complete subsidence of symptoms within a few days.

CASE II. J. W. H., a thirty-one year old white man was seized with a typical tennis elbow syndrome of the right upper extremity on September 2, 1952. There was tenderness over the lateral epicondyle of the right humerus. A single injection of 25 mg. (1 cc.) of hydrocortisone was placed directly into the common extensor tendon at the most tender spot. His symptoms were completely relieved within several days.

CASE III. Dr. J. B. first consulted us on January 24, 1952. He stated that on January 5, 1952, he had bumped his right elbow against the edge of a door. It was described as affecting

the outer aspect of the olecranon process. He claimed that while using a dental forceps considerable pain occurred over the outer aspect of his right elbow. The pain was aggravated by flexion of the elbow and on twisting movements of the forearm. Examination disclosed a definite swelling over the lateral epicondyle of the humerus between the epicondyle and the olecranon. Forced extension of the forearm with wrist flexion produced pain over this lateral epicondylar area. Twenty-five mg. (1 cc.) of hydrocortisone was given into the tender area with gradual remission of symptoms and a considerable amount of relief during the next week. When seen again on February 14, 1952 there was no further palpable thickening and only a little bit of tenderness on the posterior aspect of the lateral epicondyle of the humerus. There was no further pain on motion. He was able to carry on his dental work without difficulty.

CASE IV. W. F., a thirty-five year old white woman was seen in July, 1952, with a typical picture of tennis elbow of the left upper extremity. The elbow pain had been present for two months. There was tenderness over the lateral epicondyle with pain over the lateral epicondyle on clenching the fist and flexing the wrist. Previous treatment had consisted of physical therapy, x-ray therapy and procaine infiltrations. These had been of no help. She was given 25 mg. (1 cc.) of hydrocortisone into the tender area of the left elbow. There was some increase in soreness for twenty-four hours following the injection, but within one day there was marked improvement of symptoms which lasted for two weeks. At the end of two weeks she had a return of symptoms which were not as severe as had been previously noted. The second injection of 25 mg. (1 cc.) was given with no improvement. Physical therapy was reinstituted. There was good response to physical therapy after four weeks.

CASE V. W. M., a forty year old white man with a typical story of tennis elbow of about six weeks' duration was given one injection of 25 mg. (1 cc.) of hydrocortisone and one week later there was marked improvement. Two weeks later there was full improvement. At the end of four weeks there was no further difficulty and he was discharged.

COMMENTS

Five cases of tennis elbow were treated with the local instillation of 25 mg. (1 cc.) of hydrocortisone. Dramatic relief was obtained in four cases. One case did not respond to the injection, but gradually subsided on further conservative treatment. The rationale of using hydrocortisone locally in the region of the external epicondyle is the inhibition of fibrous tissue formation. It is believed that tennis elbow is basically an incomplete tear of the origin of the extensor muscles of the forearm from the lateral epicondyle. Repeated attempts at repair are constantly interrupted by further functional trauma. Hydrocortisone, by inhibiting granulation tissue formation, interrupts the vicious cycle of attempts at repair in the face of repeated functional stress, with secondary vascular and nerve reactions. It would also be logical to suppose that in these few cases, in which a possible radiohumeral bursa existed and had become inflamed, the local injection of hydrocortisone in and around the bursal area would give similar effects at the lateral epicondyle to those observed elsewhere; hence its use in the radiohumeral bursitis variant of tennis elbow would be indicated.

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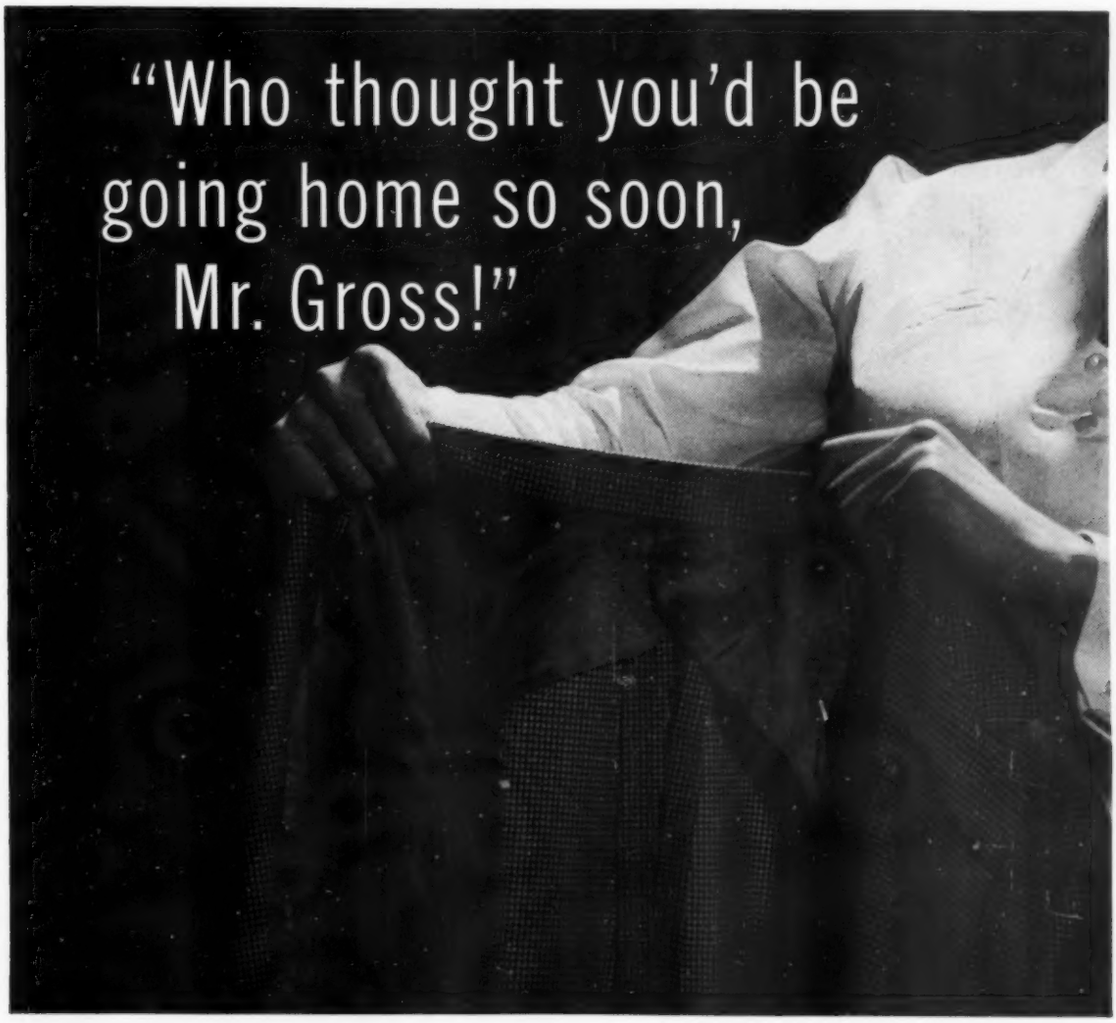

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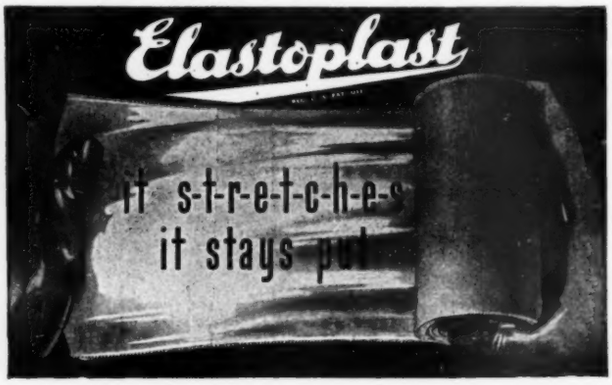

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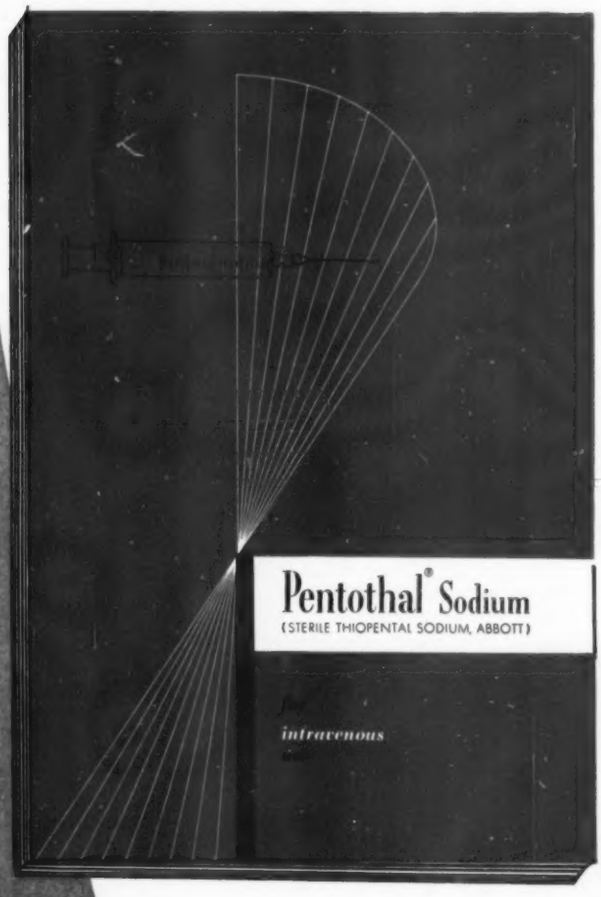

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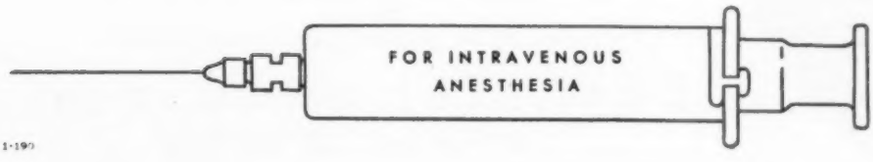

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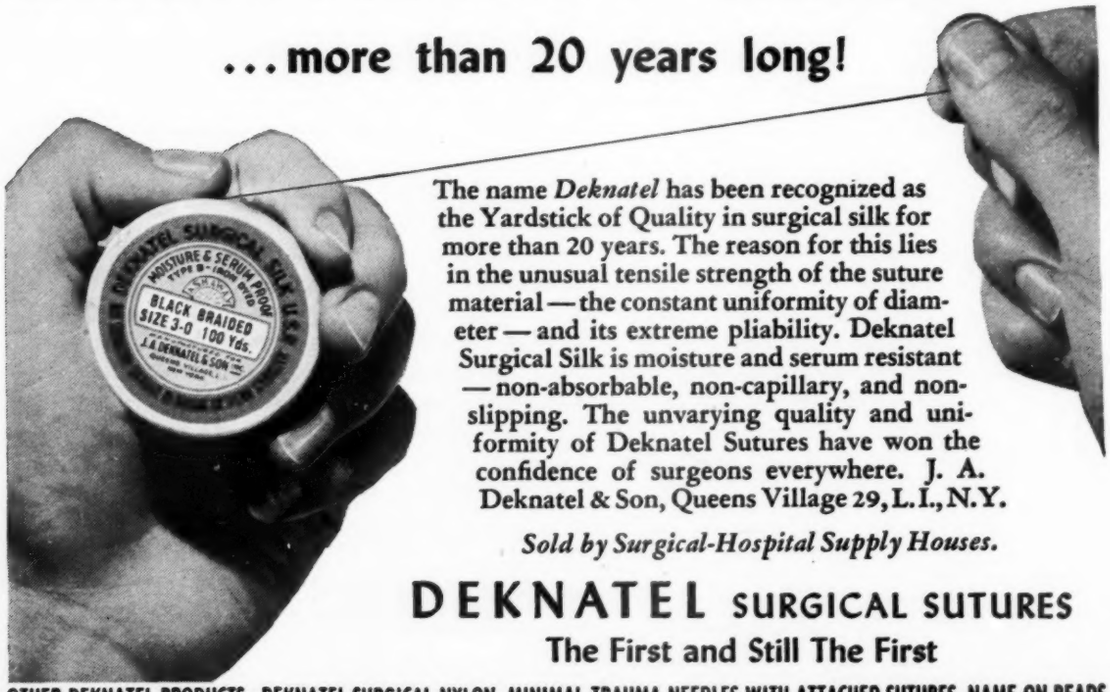

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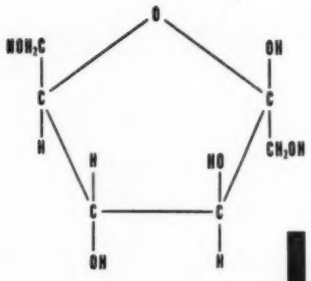

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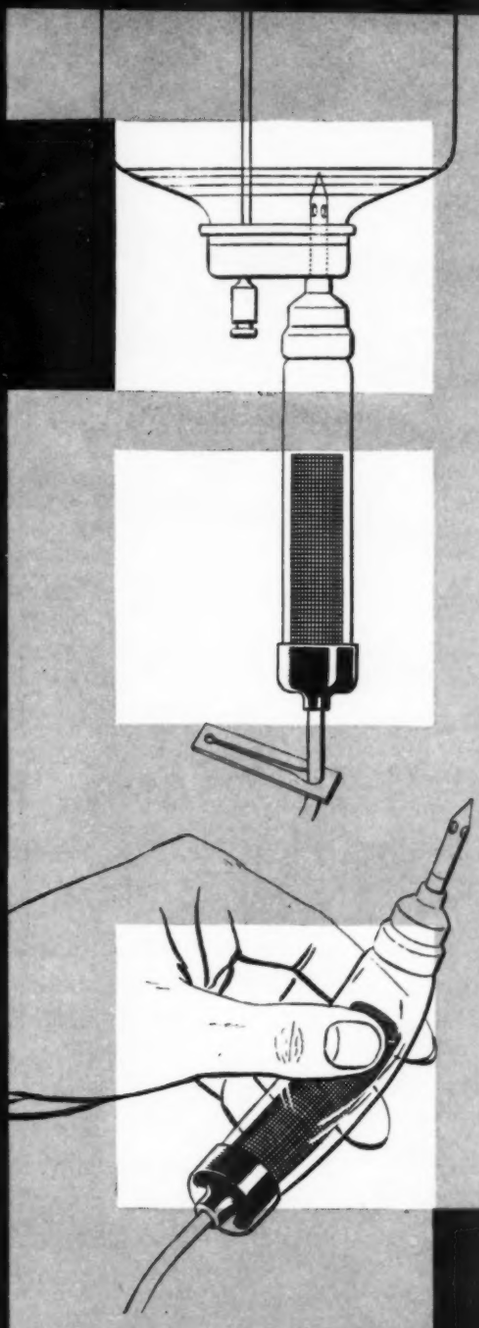

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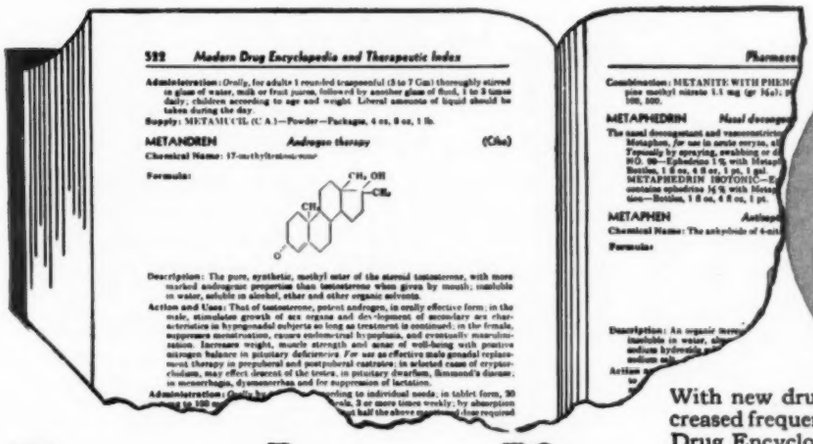
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Outside the Ivory Tower

FEMALES are increasing more rapidly in number than males in most areas of the world, statisticians of the Metropolitan Life Insurance Company report. This trend is seen not only in countries where males are still in the majority, but also where females have long had superiority in numbers. Females now outnumber males in almost all the European countries, the statisticians point out. This is particularly true in the Iron Curtain countries, where Eastern Germany, with 743 males for every 1,000 females, has the greatest imbalance of the sexes in Europe and probably in the world. The other satellite countries, except Bulgaria, also show relatively low ratios of males to females.

No post-war figures are available for the Soviet Union, but there is good reason to believe that it has a considerable deficit of males. In 1939 the ratio there was 920 males for every 1,000 females. With the heavy losses suffered by the Soviet Union in World War II, it is likely that the ratio is even lower now. On our side of the Iron Curtain, Austria and Western Germany have the largest deficit of males. In Finland, France, Spain and the British Isles the number of men is also well below that for women.

Emigration has been one of the major historic factors in depleting Europe's male population, at the same time building up surpluses of men in the New World. At the turn of the century there were 1,044 males for every 1,000 females in the United States, and males maintained their numerical superiority until recent years. In Australia and New Zealand, relatively newly settled areas, men are still in the majority by a slight margin.

"The situation in Africa and Asia is more difficult to determine," the statisticians conclude, "since large parts of these continents have never been fully enumerated. The countries for which figures are available show a mixed picture. Egypt, Japan and Korea have more females than males. On the other hand, the Union of South Africa, India, Pakistan and the Philippine Islands have more males than females. In some of the Far Eastern countries the female population is reduced by infanticide and by a very high maternal mortality. There is also a tendency in that part of the world to underenumerate females in their censuses."

WE list a few new books which we can recommend to those who might be interested in a particular subject, or who might wish to add one or more volumes to their library. We receive many books for listing or review. Many are of minor importance; others are so below par we just pass them by. We make it a practice not to criticize a worthless or commonplace work adversely—we simply ignore it. Those books we list we believe, or are advised by those who are in the "know" in a particular field, are above average and we recommend them for your consideration.

The Macmillan Company has brought out a large volume (1,253 pages), The Management of Abdominal Operations. It is edited by Rodney Maingot, F.R.C.S., and is presented in three parts, some thirty-three authors having written its forty-seven chapters. There is an index of names, an index of subjects, 532 illustrations in 328 figures, and references at the chapter endings. This is a work every young surgeon should possess and every old, established surgeon should have in his library. To our way of thinking we could compare this monumental work with the latest edition of Webster's New International Dictionary—in our estimation the best workable dictionary published to date. *Price:* $24.00.

A worth while small book, Surgery of the Esophagus, by R. H. Franklin, M.B., B.S., F.R.C.S., has been published by the Williams & Wilkins Company. It is illustrated, with some of the illustrations in color. It boasts of references at chapter endings and a workable index. If interested in this subject, it would pay dividends to possess a copy. *Price:* $8.50.

THREE new instruments designed to give the combined benefits of oxygen and medication to patients with silicosis, emphysema or similar diseases have been presented by the Berks County Allergy Committee to the three Reading, Pennsylvania hospitals. A 1952 campaign provided funds for purchase of the "MSA Pulmonary Ventilators," a development of Mine Safety Appliances Company, Pittsburgh, Pa., through Capitol Surgical Supply Co., Harrisburg. Oxygen flows under pressure through the hose, picks up medication and carries it through the facepiece to the patient's respiratory system.

(continued on page 44)

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The Surgical Engineering Company, Inc.

Outside the Ivory Tower

(*continued from page 42*)

MEDICAL educators must restructure the entire medical curriculum to meet the changing health needs of today, according to Dr. George Packer Berry, dean of Harvard Medical School and a member of the Board of Directors of the Commonwealth Fund, writing in the March issue of *The Journal of Medical Education*. Dr. Berry names freedom of opportunity for good health as a basic human right and declares "that this opportunity for good health should be provided for all is an insistent and growing demand." This movement must come from the medical profession itself and properly starts with the education of future doctors. Dr. Berry goes on to say, "Let us not forget that if we do not do some very hard thinking and acting right now, some one whom we believe to be less competent than we will do the acting for us without thinking. If we believe that we are the best architects, it is up to us to produce the plans."

After outlining some of the plans for active revamping of the medical curriculum now under way, Dr. Berry describes a six-year program of Teaching Institutes to be sponsored by the Association of American Medical Colleges. The purpose of the Teaching Institutes will be to examine the medical curriculum critically to determine what changes should be made to bring it up-to-date.

Advances in medicine have increased life expectancy by a third since 1900, says Dr. Berry, and in so doing have contributed to the creation of new and difficult problems which medicine must help to solve. Medicine must train men to serve the whole patient rather than merely to cure disease or aid disabilities. This calls for extensive revision of the medical curriculum.

The first AAMC Teaching Institute will be held next fall at Atlantic City, N. J., immediately preceding the 64th annual meeting of the Association of American Medical Colleges, October 26–28. The areas covered will be the teaching of physiology, biochemistry and pharmacology. Every medical school in the country will be invited to participate. Future conferences will cover pathology, microbiology, immunology and genetics; anatomy, histology, embryology and anthropology; medical ecology; clinical teaching, including the internship; specialty training and the continuing education of the physician.

Dr. Berry indicates that many medical schools have already undertaken programs to revise their curricula. He cites Western Reserve University, where a new curriculum was inaugurated this fall and is being watched with interest by medical educators. Other schools mentioned as conducting experiments in their curriculum include Harvard, the University of Tennessee, Boston University, the University of Colorado and Cornell.

THE Atlas of the Skeletal Development of the Rat, Normal and Hypophysectomized, was ready for publication in May. It was published by the newly established American Institute of Dental Medicine, which is a non-profit organization incorporated under the laws of the State of California. It will be published in original 8½" x 11" double weight, glossy contact prints with a text of approximately 45 pages. The edition will be limited to 300 copies.

THE three winners of the 1952 seventh annual Schering Award competition among medical students have been announced by Dr. M. William Amster, chairman of the award committee. One award of $500 was presented to Edward Allen Jones, a sophomore at Meharry Medical College, Nashville, Tennessee, for the outstanding paper on "Steroid Hormones in Geriatrics." The $500 award for the outstanding paper on "The Topical Uses of Antihistamines" was given to Seymour Cohen, senior medical student at the State University of New York at Syracuse. Another $500 award goes to William Howard Spencer, junior at the School of Medicine, University of California Medical Center, San Francisco. His winning paper is entitled "Chemotherapy of the Eye."

DOCTORS are urged to make arrangements as soon as possible to attend the Sixth Pan-Pacific Surgical Congress to be held in Honolulu, Hawaii, October 7–18, 1954. An outstanding program, including sessions in all divisions of surgery and related fields, promises to be of interest to all doctors. For further information, write to Dr. F. J. Pinkerton, Director General, Pan-Pacific Surgical Association, Suite 7, Young Hotel Building, Honolulu, Hawaii.

(*continued on page 46*)

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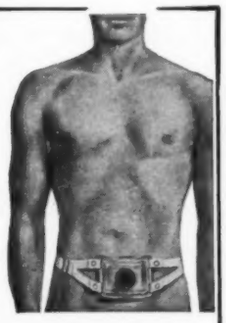

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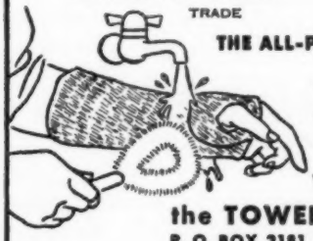

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Outside the Ivory Tower

(*continued from page 44*)

ARTICLES by thirty leaders in the atomic energy field appear in a transcript released May 25, 1953, by the National Industrial Conference Board. The following recognized authorities on medical and pharmaceutical applications of atomic energy are among those represented: Donalee L. Tabern, Head, Department of Radioactive Pharmaceuticals, Abbott Laboratories; Dr. Bernard Roswit, Director, Radioisotope Unit, U. S. Veterans Administration Hospital, Bronx; Dr. Edith H. Quimby, Associate Professor of Radiology, College of Physicians and Surgeons, Columbia University; D. A. McGinty, Laboratory Director in Physiological Research, Parke, Davis & Company, and Charles Rosenblum, Head, Radioactivity Laboratory, Merck & Co., Inc.

Subjects covered include medical and pharmaceutical applications of atomic energy, agricultural and food processing applications, current uses of atomic by-products in industry, the place of nuclear power in the nation's power supply and problems of industrial participation in atomic power development.

STEPS are being taken to protect children from toxic paints and highly flammable clothing. This was announced today by Vice Admiral George F. Hussey, Jr., managing director of the American Standards Association. The Association's Sectional Committee on Hazards to Children has authorized technical subcommittees to set up safety standards on the proper identification of non-toxic paints and on the flammability of children's clothing. While most manufacturers of children's toys and furniture use non-toxic paints on their products, the New York City Health Department has reported a number of illnesses and deaths of children who have chewed paint from such articles.

The Committee brought out that poisoning from the direct contact with painted surfaces generally involves objects which have been repainted in the home with paint not intended for the purpose. The technical group in this area, to be appointed, will determine which ingredients of paints are safe from a toxicological viewpoint. The labeling of paints as being "safe" will indicate that surfaces painted with these products, if chewed, should not cause poisoning by the paint. The subcommittee which will investigate the question of flammability of children's clothing will make use of an existing American Standard Test Method for Flammability of Clothing Textiles. (This test method has Class I flammability requirements.) Textiles conforming to Class I under this test method are considered of normal flammability, that is, having no unusual burning characteristics.

DEATHS from tuberculosis among the nation's 88,000,000 life insurance policyholders fell to an all-time low mark in 1952, indicating how effective has been the battle against this long-time scourge, the Institute of Life Insurance reports today. At the same time, deaths from heart disease among U.S. policyholders reached a record high. Heart disease was the No. 1 killer last year, accounting for well over half of all policyholder deaths. Tuberculosis, killing nearly one-fourth fewer policyholders than it did the year before, showed the greatest percentage drop of any year on record and accounted for only about 2 per cent of total deaths. The current death rate from this cause is a small fraction of the rate at the turn of the century.

The death rate among policyholders, all causes combined, held at about the same low level of the past several years. It was 6.4 per 1,000, the same as the year before. The all-time low was 6.3, recorded in 1950. The 1952 rate was 11 per cent under the average of the Forties and 23 per cent lower than the average of the Thirties.

PARKE, DAVIS & COMPANY announced a new series of advertisements will be addressed to the general public on the importance of prompt and proper medical care. Ralph G. Sickels, director of advertising and public relations for the pharmaceutical firm, explained that the central theme will be: "In the hands of your physician, you're in good hands." The advertisements, he added, will emphasize that medical science has a vast store of new knowledge, and that this knowledge is constantly increasing through worldwide research. Although Parke, Davis has been stressing the "See Your Doctor" theme in its national advertising for twenty-five years, the new series will present copy and layout which are not only different but also unusually fresh, provocative and effective.

(*continued on page 48*)

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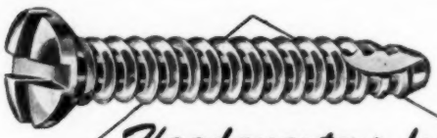

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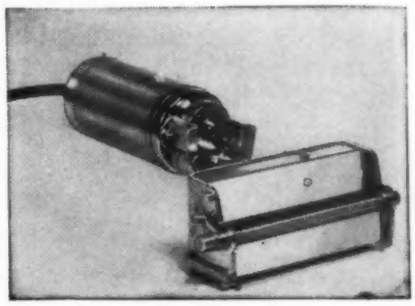

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Outside the Ivory Tower

(*continued from page 46*)

RECIPIENTS of the first six two-year Lowell M. Palmer Senior Fellowships in the Medical Sciences totalling $88,000 were announced by Dr. Walsh McDermott, Associate Professor of Medicine, Cornell Medical College, and Dr. Geoffrey Rake, Medical Director, E. R. Squibb & Sons, Chairman and Vice Chairman, respectively, of the Selection Board of the Lowell M. Palmer Fund.

The Fellows and their specific fields are:

Dr. Joseph Dancis, New York University College of Medicine (Physiology of Newborn); Dr. Franklin W. Heggeness, University of Rochester, New York (Physiology of Gastrointestinal Tract); Dr. Charles A. LeMaistre, Cornell University Medical College (Chronic Bacterial Infections); Dr. William R. Milnor, The Johns Hopkins University School of Medicine (Cardiovascular Research); Dr. David Karzon, University of Buffalo (Viral Infections) and Dr. Maurice S. Raben, Tufts College Medical School (Pituitary Hormones).

THE Lowell M. Palmer Fund was established this year by Carleton H. Palmer, retired Board Chairman of E. R. Squibb & Sons, as a private philanthropy in memory of his father. The fund is administered by Cornell Medical College. It is designed to provide substantial support for young medical teachers and research scientists of exceptional ability who have completed post-doctorate fellowships and deserve additional assistance in order to remain in full-time academic medicine. Fellowship awards will be made annually.

Other members of the Selection Board are: Dr. Robert F. Loeb, Professor of Medicine, College of Physicians and Surgeons, Columbia University; Dr. Charles Janeway, Professor of Pediatrics, Harvard Medical School; Dr. Samuel B. Wortis, Professor of Psychiatry and Neurology, New York University College of Medicine; and Dr. A. McGehee Harvey, Professor of Medicine, Johns Hopkins University.

THE age of the mother at pregnancy may endow the offspring with many characteristics, including either a susceptibility or a resistance to cancer, a Yale University geneticist has found. This was announced here by the American Cancer Society, which supports research by the scientist, Dr. Leonell C. Strong, Research Associate in Anatomy at the Yale School of Medicine. Dr. Strong, noted for his development of many famous strains of inbred mice, believes that these observations apply not only to the mice with which he has worked but to other animals and humans as well.

A better understanding of resistance and susceptibility is important as it may possibly provide a means of controlling cancer. Dr. Strong has found that mice in late litters, that is from older mothers, are less susceptible to cancer than mice in early litters from the same mother. He and other scientists have shown that the mother's age influences three distinctly different kinds of malignancy: induced cancer of connective tissue, virus-caused cancer of the breast and leukemia. The first two types increase with the mother's age while leukemia decreases. Other scientists, he points out, have found that some animals born early in the mother's life live longer than those born later. In this phenomenon of longevity may lie the secrets of aging and susceptibility to cancer.

A NEW yardstick to measure worry was announced by a Duke University psychologist. Dr. Sanford Goldstone told the North Carolina Psychological Association of a "light-flicker" test to determine how worried a person is, and to study the relationship between worry and fatigue, heart disease and other illnesses. Duke psychologists discovered the possibility of these applications in developing the test as a new diagnostic tool to measure the effectiveness of psychiatric treatment. During the test, a patient sits facing a light in a darkened room. As the researcher raises and lowers the flicker rate of the light source, the patient tells him when the flicker turns into a steady glow or vice versa.

The doctors actually are measuring anxiety, a psychiatric term used to describe a common nervous condition of excess worry, nameless fears and dreads, nervousness, tension, disturbed sleep and such physical symptoms as shortness of breath, rapid heart beat, dizzy spells and weakness. In a study of seventy-four normal and ill patients at Duke Hospital, doctors found that highly anxious people are less sensitive to flicker than more normal individuals. The highly anxious person sees a steady light whereas more normal people usually see a flicker.

(*continued on page 50*)

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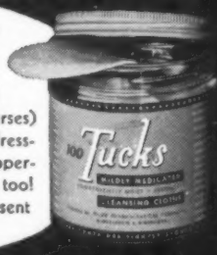

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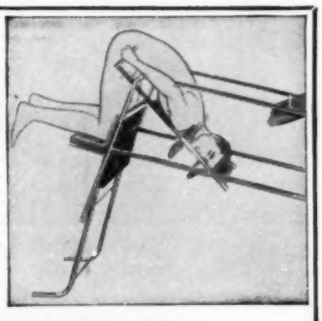

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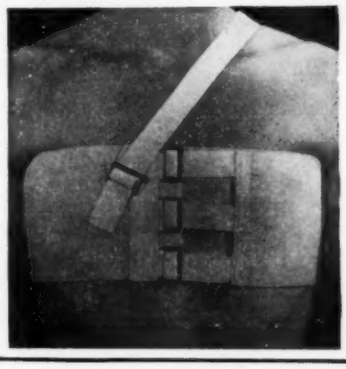

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Outside the Ivory Tower

(*continued from page 48*)

A PRIZE of $1,000, donated by the Kappa Delta Sorority, may be awarded annually by the American Academy of Orthopedic Surgeons for the best research related to orthopedic surgery and performed by an American citizen in the United States. The selection will be made from publications after January 1, 1951, or research presented to the Committee on Scientific Investigation of the American Academy of Orthopedic Surgeons before November 1, 1953. Researchers interested in competing for the award are requested to secure further information from Dr. John J. Fahey, Chairman of the Committee on Scientific Investigation of the American Academy of Orthopedic Surgeons, 1791 West Howard Street, Chicago 26, Illinois.

ON July 1st more than 6,000 new doctors from U.S. medical schools will have begun internships at hospitals throughout the country. As a result of a national matching plan, now in its second year of operation, 95 per cent of the interns will complete their formal medical training at the hospital of their first or second choice, according to a report on the recently completed program in the April issue of *The Journal of Medical Education*. Eighty-five per cent of the students received their first choice internship. The national matching plan was set up last year to lessen difficulties caused primarily by the disparity between the number of internships and doctors available to fill them. The difference between the number of internships and available new doctors continued this year at about the same rate. While 6,033 students participated in the plan, some 10,971 internships were offered.

DIATHERMY treatment of various ailments by institutions and physicians has become increasingly widespread in recent years. However, the operation of this equipment has created a problem of which many users may not be fully aware. When operating, many diathermy machines emit radio frequency energy upon frequencies which the Federal Communications Commission must keep clear of interference. Then, too, occasionally equipment is modified for special applications or experimental work and this may cause r-f emission outside of assigned frequency bands. For these reasons, the F.C.C. has expressed its intention of seeking out all offenders shortly. Accordingly, it is likely that any diathermy installations employing offending apparatus will receive notification to remedy the condition at once. It is also possible that manufacturers of such equipment will find themselves in difficulty with their customers. While their current models may comply with F.C.C. regulations in every way, earlier but still serviceable units of their manufacture may not. The crack-down was due to take place beginning June 30, 1953, the F.C.C. has indicated. Many offenders have already been located and patrolling mobile monitors with direction finders are locating more all the time.

DEANS of five medical schools have selected the most meritorious papers from their respective institutions and the students who submitted them will receive special Dean's Awards from the Schering Award Committee. These prizes, $100 each, are the latest to be added in order to widen recognition among the increasing number of participants in the nationwide competition. Deans of schools with the most participants are invited to make the selections.

The five winners, according to an announcement by Dr. M. William Amster, chairman of the Committee, are: Andrew H. Jackson, senior at Meharry Medical College, Nashville, Tenn.; Mrs. Virginia T. Kenney, junior at the University of Louisville; Raymond E. Hogg, senior at the Kansas University Medical School; John Edwin Holloway, junior at the College of Medical Evangelists, Loma Linda, Calif., and Hyman W. Fisher, junior at New York University's Bellevue Medical Center.

DUKE UNIVERSITY will launch a new Medical Town-Hall for the people of Durham and the State, Dean W. C. Davison, of Duke Medical School, announced. The first program, a panel on polio, was held in Duke's Page Auditorium Sunday, June 7th. Admission to all Duke Medical Town-Hall meetings will be free. Meetings will consist of a forum, with panel discussions or talks by medical experts and questions from the floor. "We realize that there are many questions the public would like to ask doctors but never have the opportunity to ask," Dean Davison said. "They have a right to know as much as possible about medical problems and we are going to give them the opportunity."

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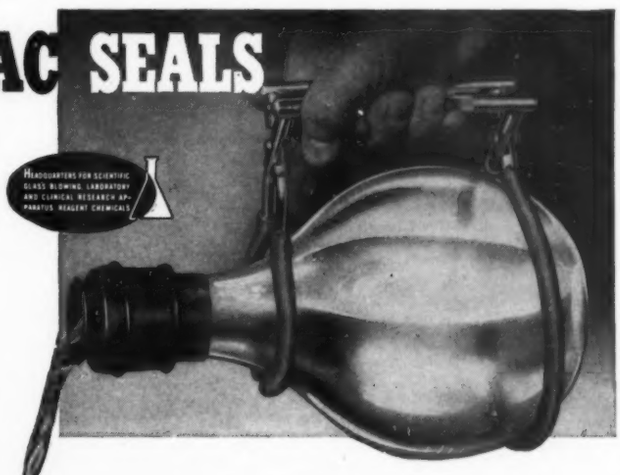

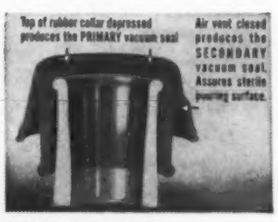
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ADVERTISERS INDEX

July, 1953

Abbott Laboratories....35, 39
American Cystoscope Makers, Inc.... 11
American Hospital Supply Corp.... 4
American Meat Institute.... 27
American Orthopedic Appliances.... 43
Ames Company, Inc.... 1
Arista Surgical Co.... 49
Arnar-Stone Laboratories, Inc.... 49
Ayerst, McKenna & Harrison, Ltd.... 21
Bard-Parker Co., Inc.... 16
Baxter Laboratories.... 4
The Berivon Company.... 24
Jayne Bryant Safety-Check Blanket Co.... 49
Campbell Associates.... 45
Chatham Pharmaceuticals, Inc.... 18
Ciba Pharmaceutical Products, Inc...*Back Cover*
Cochrane Physicians' Supplies, Inc.... 43
Cook County Grad. School of Medicine... 38
Crescent Surgical Sales Co., Inc.... 34
Cutter Laboratories.... 33
Davis & Geck, Inc.... 9
J. A. Deknatel & Son, Inc.... 36
Dome Chemicals, Inc.... 36
Drug Publications, Inc....40–41
Duke Laboratories, Inc.... 34
Eaton Laboratories, Inc.... 8
Eder Instrument Co.... 49
Ethicon Suture Laboratories, Inc....
Insert Facing Page 16
Etna Appliance & Equipment Co., Inc.... 45
Exakta Camera Company.... 45
Fuller Pharmaceutical Company.... 49
Gomco Surgical Manufacturing Corp.... 19
John F. Greer Company.... 51
Kansas City Assemblage Co.... 47
Kny-Scheerer Corporation.... 10
Lanair Chemical Corp.... 51
Lederle Laboratories..*Insert Facing Page* 8, 12–13
Eli Lilly & Co.... 32
Little Manufacturing Co.... 49
Macalaster Bicknell Parenteral Corp.... 51
MacGregor Instrument Co.... 47
Mead Johnson & Company....30, 37
Medical Aids, Inc.... 51
Medical Fabrics Co., Inc.... 43
V. Mueller & Co.... 23
N. Y. Polyclinic Medical School & Hospital 38
Orthopedic Equipment Co.... 45
Orthopedic Frame Company....43, 45
Outside the Ivory Tower....42, 44, 46, 48, 50
Parke, Davis & Company.... 31
Murle Perry.... 43
Chas. Pfizer & Co., Inc....17, 25
George P. Pilling & Son Co., Inc.... 14
The Radium Emanation Corp.... 43
A. H. Robins Co., Inc.... 15
Seal-Ins Laboratories, Inc.... 47
G. D. Searle & Co.... 28
Siebrandt Fracture Equipment, Inc.... 47
E. R. Squibb & Sons, Division of Mathieson Chemical Corp.... 6
The Surgeon's Mart....43, 45, 47, 49, 51
The Surgical Engineering Co., Inc.... 43
The Tower Co., Inc.... 45
The Upjohn Company.... 52
Wallace & Tiernan Products, Inc.... 47
Winthrop-Stearns, Inc.... 2
World Medical Association.... 26
Wyeth, Inc.... 29
Louis Yellin, Inc.... 22
F. E. Young & Co.... 45
Zimmer Manufacturing Co....20, 47

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